MMR Doc. No.
11043

AF CENTER FOR ENVIRONMENTAL EXCELLENCE

Massachusetts Military Reservation

FINAL
~~Draft~~

FS-12
PLUME CONTAINMENT SYSTEM
PROJECT EXECUTION PLAN

~~September 1996~~ Dec 97

Prepared for:
AFCEE/MMR
Installation Restoration Program
322 E. Inner Road Box 41
Otis ANGB, MA 02542
DSN: 557-4670 Comm: 508-968-4670

Prepared by:
Jacobs Engineering Group Inc.

Document No.: AFC-J23-35K78404-M1-0001

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ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Environmental Excellence
ANG	Air National Guard
ANSI	American National Standards Institute
ARNG	Army National Guard
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AVGAS	aviation gasoline
AWWA	American Water Works Association
bgs	below ground surface
CGN	Camp Good News
COE	Army Corps of Engineers
CQP	Construction Quality Plan
DOD	U.S. Department of Defense
DTW	Depth-to-water
EDB	ethylene dibromide
EPA	U.S. Environmental Protection Agency
ETR	Extraction, Treatment, Reinjection
FAR	Federal Acquisition Regulations
FS	fuel spill
ft/day	feet per day
ft/ft	foot per foot
ft^2/day	square feet per day
GIS	Geographic Information System
gpm	gallons per minute
GPS	Global Positioning System
HSP	Health and Safety Plan
IDM	investigative-derived materials
IRP	Installation Restoration Program
JP-4	jet propellant 4
JPAT	Join Process Action Team
lbs/ft	pounds per foot

ACRONYMS AND ABBREVIATIONS

MCL	maximum contaminant level
MDEP	Massachusetts Department of Environmental Protection
MLS	multi-level sampler
MMR	Massachusetts Military Reservation
MSL	mean sea level
P&IDs	Process & Instrument Diagrams
PFDs	Process Flow Diagrams
PME	performance monitoring evaluation
QPP	Quality Program Plan
RI	remedial investigation
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedures
SWD	Sandwich Water District
TRET	Technical Review and Evaluation Team
USAF	United States Air Force
USCS	Unified Soil Classification System
UVO	ultraviolet oxidation
VOC	volatile organic compound
µg/L	micrograms per Liter

1.0 INTRODUCTION

This Project Execution Plan has been prepared for the United States Air Force Center for Environmental Excellence (AFCEE) as part of the U.S. Air Force (USAF) Installation Restoration Program (IRP) under Remedial Action Contract No. F41624-94-D-8115 Delivery Order No. 25. The project described herein is one component of the Strategic Plan developed by the U.S. Air Force to remediate groundwater contamination at the Massachusetts Military Reservation (MMR) in Cape Cod, MA (AFCEE 1996). Specifically, this plan addresses the capture and remediation of FS-12 (Fuel Spill number 12) plume located north of Snake Pond.

The goal of the FS-12 plume containment project is to identify a network of extraction and reinjection wells that will capture as near to 100% of the plume as possible without unacceptable ecological, hydrological, or other impacts. Based on the extent and characteristics of the FS-12 plume as described in the Data Gap Technical Memorandum (OpTech 1996a) and a balanced assessment of beneficial and adverse impacts associated with groundwater pumping effects, a network of 30 extraction and 30 reinjection wells was proposed as the basis for final design (OpTech 1996b).

The purpose of this execution plan is to define the actions needed to complete the design/engineering/construction and operation/monitoring of the extraction, treatment, reinjection (ETR) system and describe the management/technical approach for executing those actions. As a preface to the discussion of those topics, a brief summary of the site and plume characteristics is presented below.

The Plan also outlines anticipated activities associated with system design refinement, installation, operation, and performance monitoring. Detailed information describing the system design basis and system installation and operation will be provided under separate cover in the FS-12 Draft Design Package scheduled to be submitted on October 21, 1996.

1.1 MMR SITE LOCATION AND DESCRIPTION

MMR encompasses approximately 22,000 acres on western Cape Cod, Massachusetts, about 60 miles south of Boston (Figure 1-1). It is located in Barnstable County, and is bounded by the towns of Bourne, Falmouth, Mashpee, and Sandwich. The reservation houses various facilities and related operations of the following Department of Defense (DOD) branches: U.S. Coast Guard, U.S. Marine Corps, U.S. Army National Guard (ARNG [Camp Edwards]), U.S. Air Force, and U.S. Air National Guard (ANG [Otis ANG Base]). Portions of the base are used by the Veterans Administration National Cemetery, the U.S. Department of Agriculture, and the Commonwealth of Massachusetts. Most facilities are in the southern portion of the reservation. The northern portion consists of several firing ranges which the ARNG uses for training with live ammunition.

Since its establishment in 1911, a variety of activities have been conducted on MMR, including troop training and deployment; fire-fighting training; ordnance development, testing and training; aircraft and vehicle operation and maintenance; and fuels transport and storage. Most activities can be associated with either mechanized army training, maneuvers and associated functions, or with military aircraft operations, maintenance, support, and associated functions. Operations on the reservation intensified during and just after World War II (1940 to 1946). From 1955 to 1970, a substantial number of surveillance and air defense aircraft operated out of the ANG portion of the reservation. Since that time the intensity of operations has slowed, and currently a single reserve fighter squadron trains out of this airfield.

The FS-12 Plume Area lies in an area outside the bounds of MMR in the village of Forestdale, within the town of Sandwich, Massachusetts. It also includes most of Camp Good News (CGN), which is located along a portion of the eastern boundary of MMR (Figure 1-2). CGN is a privately owned, summer camp facility. Some permanent residential housing exists on the property adjacent to CGN.

1.2 FS-12 PLUME

The origin of the FS-12 groundwater contamination was a leak of approximately 70,000 gallons from a section of fuel pipeline at the intersection of Greenway Road and the western entrance to L-range (ASI 1992). Both aviation gas (AVGAS) and jet propellant 4 (JP-4) jet fuel were carried through the pipeline. The leaking section of the pipeline was repaired in 1972. Contamination associated with FS-12 was first detected in 1990 when the Sandwich Water District (SWD) detected hydrocarbon odors and volatile organic compounds (VOCs), including benzene, in groundwater at two exploratory wells installed off-base on the grounds of Camp Good News. The exploratory wells were installed as part of an effort to identify suitable locations for additional water supply production wells. The remedial investigation (RI) completed in 1993 concluded that fuel leaking from the pipeline had contaminated soil and groundwater in the immediate vicinity of Greenway Road (ASI 1992).

The primary constituents in the FS-12 plume are benzene and ethylene dibromide (EDB). Figures 1-3 and 1-4 show in plan view the extent to which maximum contaminant levels (MCLs) have been exceeded for EDB and benzene, respectively, as of November 1995 (OpTech 1996a).

The majority of the FS-12 plume is migrating through glacial outwash sands and gravels. As the FS-12 plume migrates, the top of the plume descends from the water table (68 feet mean sea level [MSL]) to approximately 118 feet below the water table (–50 feet MSL) over a distance of about 5,000 feet. Plume contaminants have been detected in the upper 10 to 20 feet of the glacial lacustrine sediment underlying the outwash sands and gravels. The maximum projected width of the entire plume front normal to groundwater flow is approximately 2,300 feet, and the maximum thickness of the plume is approximately 150 feet. Figures 1-5 and 1-6 show the EDB and benzene concentrations, respectively, for cross section A-A' (OpTech 1996a). The

locations of the wells used in cross-section Figures 1-5 and 1-6 are shown in Figures 1-3 and 1-4.

Screened auger and sampling data collected during the data gap field effort indicate that both the benzene and EDB plumes continue to migrate south-southeast. The leading edge of the benzene plume has migrated to the Camp Good News entrance road. Benzene in monitoring well GMW-20 increased from a concentration of 43 micrograms per liter (μg/L) (April 1993) to 1,800 μg/L (November 1995) (OpTech 1996a).

The leading edge of the EDB plume has migrated to J. Braden Thompson Road. EDB in monitoring wells GMW-20 and GMW-40 has increased from an estimated concentration of 144 μg/L (April 1993) to 300 μg/L (November 1995), and 0.89 μg/L (March 1993) to 39 μg/L (August 1995), respectively.

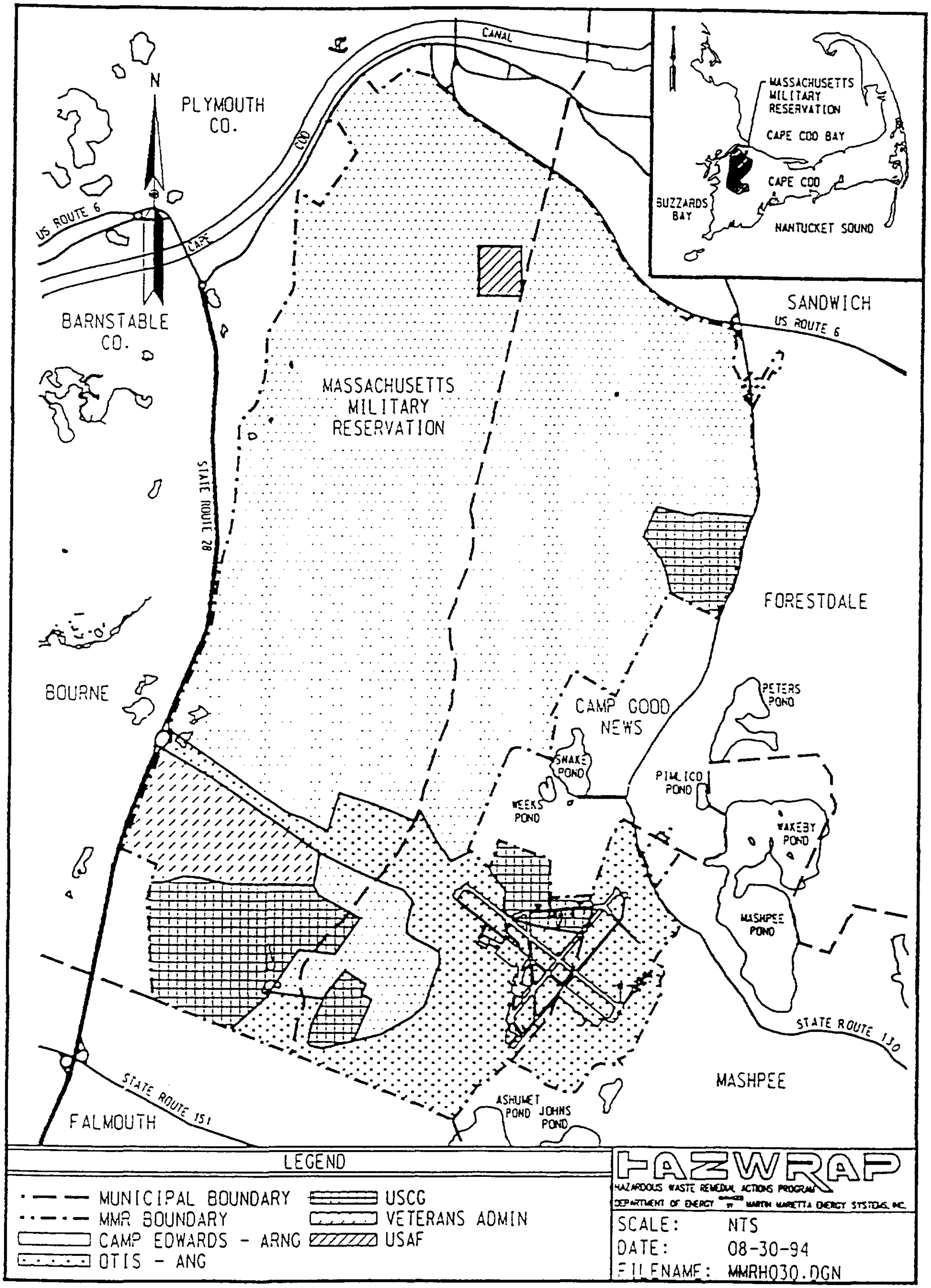


FIGURE 1-1 REGIONAL LOCATION MAP OF THE MMR AREA.

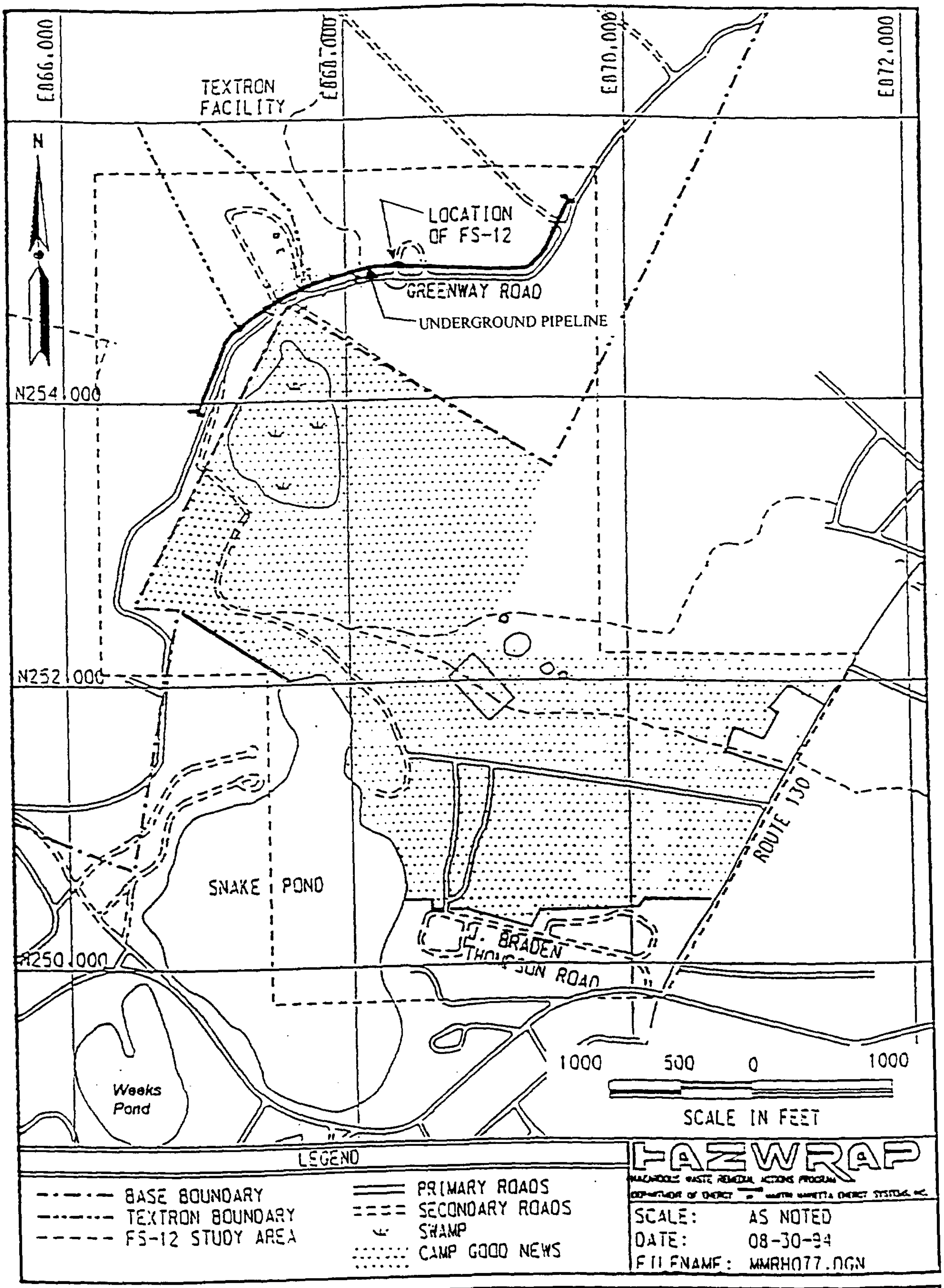
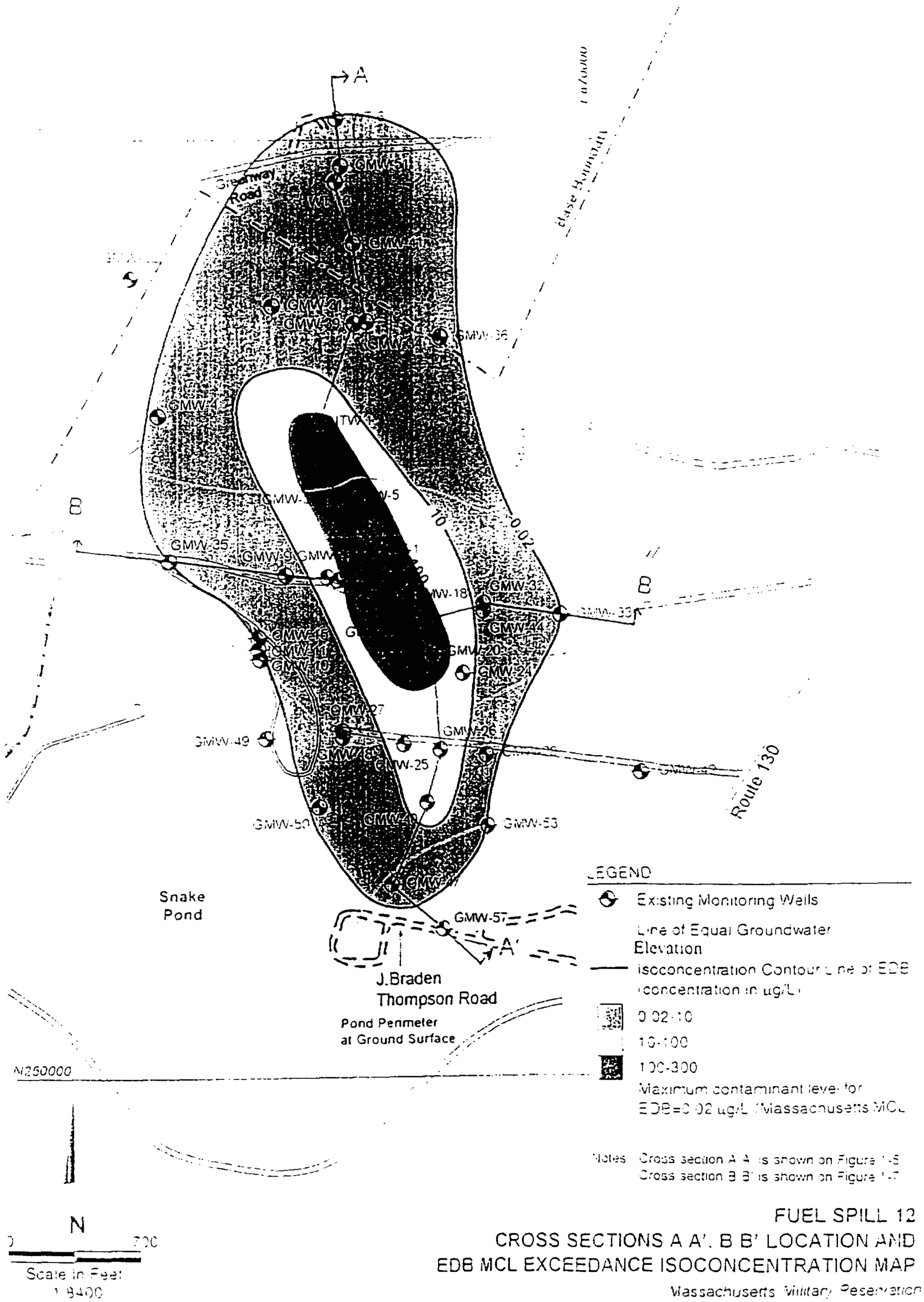
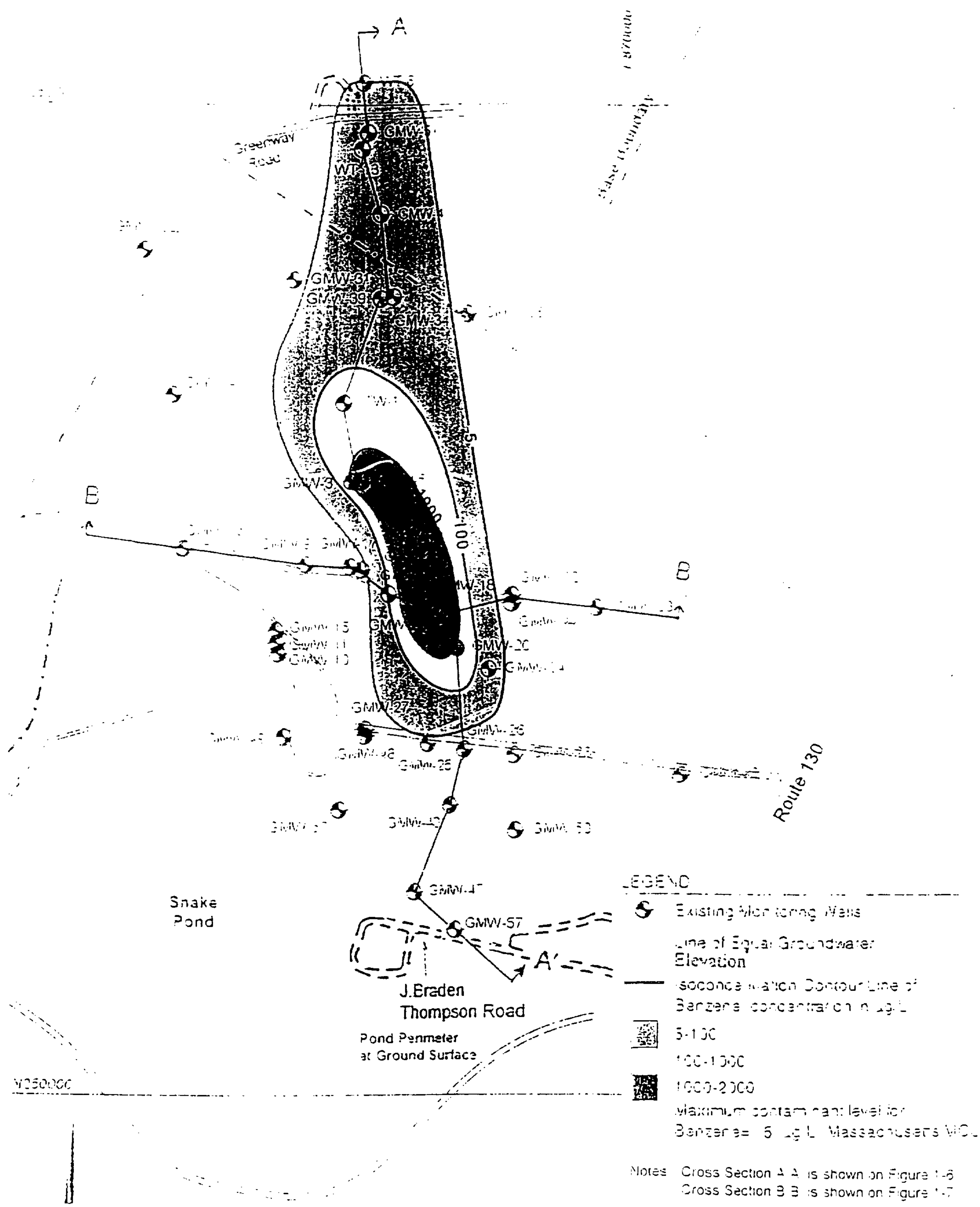


FIGURE 1-2 SITE MAP OF FS-12 STUDY AREA.



FUEL SPILL 12
CROSS SECTIONS A A', B B' LOCATION AND
EDB MCL EXCEEDANCE ISOCONCENTRATION MAP

Massachusetts Military Reservation
Cape Cod Massachusetts



FUEL SPILL 12

CROSS SECTIONS A A', B B' LOCATION AND BENZENE MCL EXCEEDANCE ISOCONCENTRATION MAP

Massachusetts Military Reservation
Cape Cod, Massachusetts

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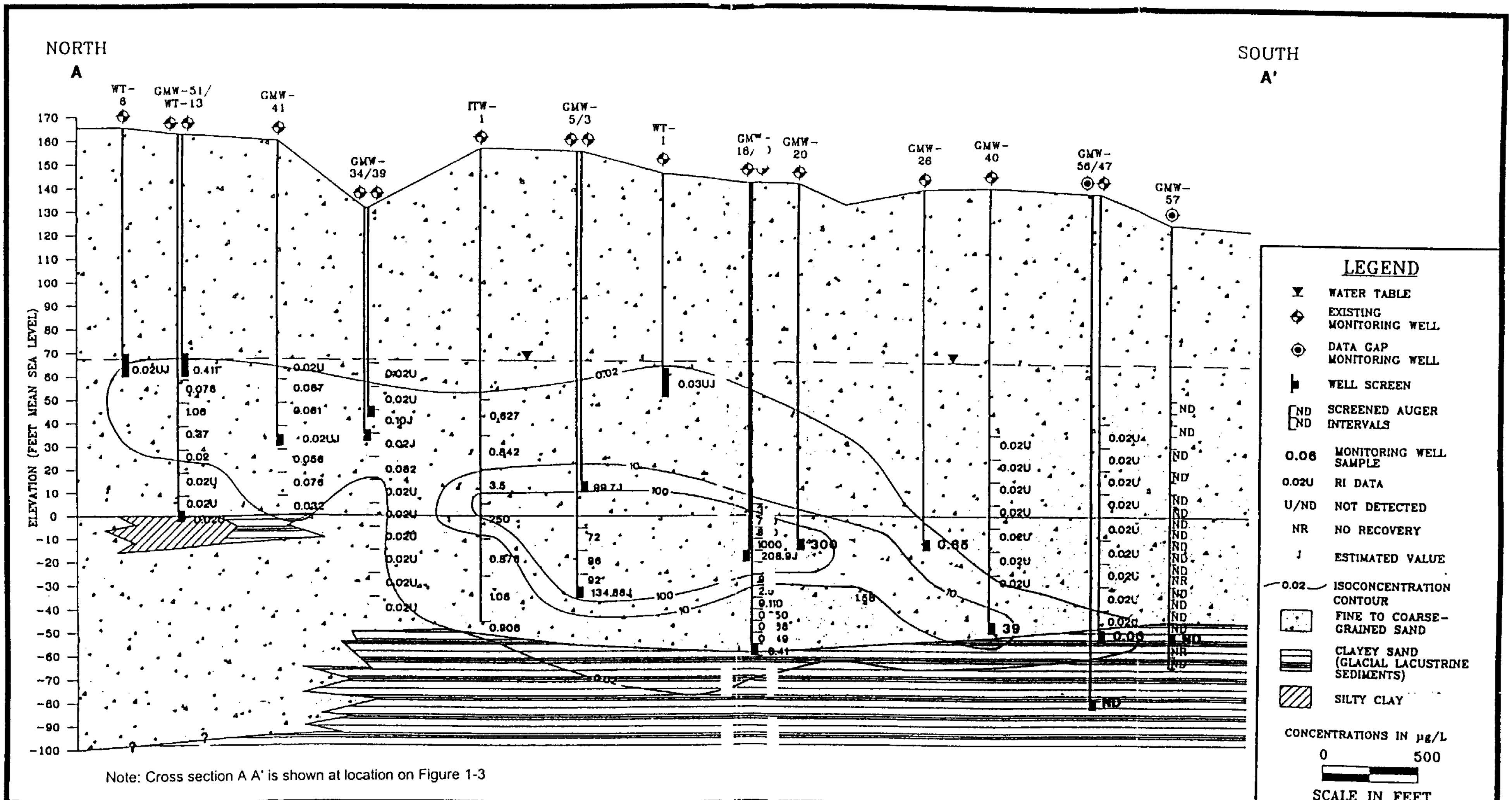
FIGURE 1-4



Note: Cross section A A' is shown at location on Figure 1-3

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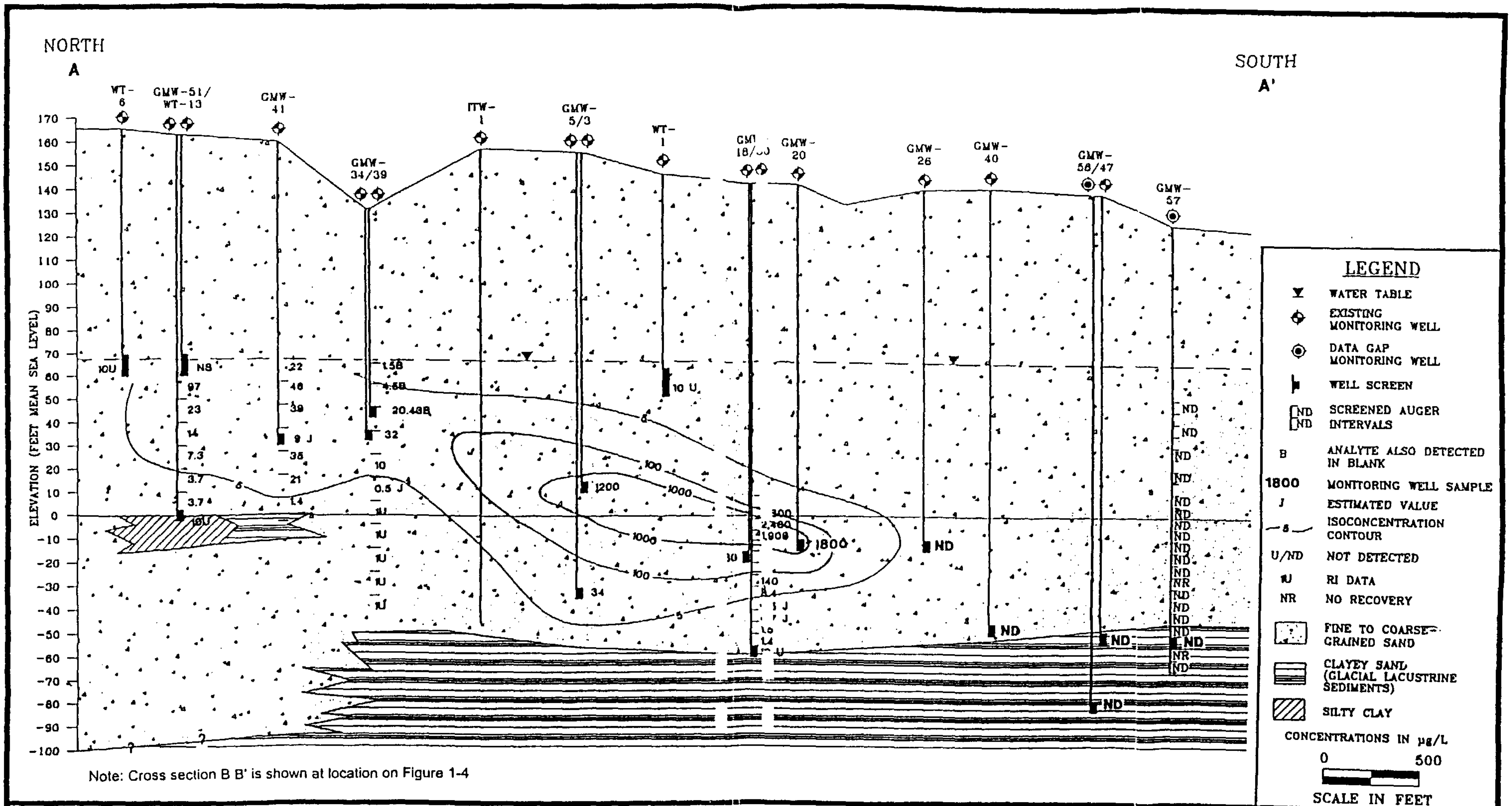
EDB ISOCONCENTRATION AND CROSS-SECTION A-A' AT FUEL SPILL-12
Massachusetts Military Reservation
Cape Cod, Massachusetts

FIGURE 1-5



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OPERATIONAL TECHNOLOGIES CORPORATION

FEBRUARY 1998

BENZENE ISOCONCENTRATION AND CROSS-SECTION A-A' AT FUEL SPILL-12
Massachusetts Military Reservation
Cape Cod, Massachusetts

FIGURE 1-6

2.0 OVERVIEW OF PROJECT ACTIVITIES

As part of the Strategic Plan (AFCEE 1996), the USAF proposed to install a groundwater remediation system at FS-12 to capture as near 100% of the plume as possible without serious impact to the environment. A target date of 27 August 1997 for startup of the system was proposed as a milestone in the Federal Facility Agreement currently being negotiated.

The extracted groundwater will be pumped to the treatment facility to undergo a series of unit operations including precipitation/flocculation, sedimentation, greensand filtration, UV oxidation, and absorption by granular activated carbon. The treated groundwater will be reinjected into the subsurface by 30 reinjection wells to minimize impacts to ecological receptors.

2.1 PROJECT STATUS

The proposed ETR network of 30 extraction and 30 reinjection wells was presented at a meeting of the Joint Process Action Team in May 1996. The computer modeling that provided the basis for that network was described in the Plume Containment Design Groundwater Modeling Report (OpTech 1996b) submitted in late August 1996. An Appendix to that report which focused on the FS-12 site had been submitted in July 1996. Regulatory and community review of those documents is ongoing, including a meeting of the Technical Review and Evaluation Team on August 28, 1996.

Contaminant concentrations were established from the Data Gap Technical Memorandum prepared by OpTech (OpTech 1996a). ETR well locations and pumping rates are summarized in Table 2-1. The proposed locations of reinjection and extraction wells are shown in Figures 2-1 and 2-2.

The design effort for the FS-12 ETR system was initiated based on the proposed ETR network and on selected components of the 60% completion design of January 1996 (OpTech 1996). It is continuing concurrently and interactively with other efforts related to FS-12.

A pumping and reinjection test was initiated in July of 1996 by OpTech at a site to the northwest of Snake Pond. The purpose of this effort is to evaluate aquifer response to reinjection and estimate aquifer properties in the vicinity of the proposed ETR network. Results of these tests are expected in late September or October of 1996.

Ecological sampling was performed in Snake Pond and other ponds, wetlands, and ecologically sensitive areas to obtain baseline data that can be used in assessing the potential impacts of changes in the ambient conditions. The efforts to develop specific criteria for identifying acceptable or unacceptable ecologic impacts is continuing for all plumes.

Most of the proposed ETR wells (with the associated transmission pipelines, power, and control structures) are located on private property (Camp Good News) to the east and northeast of Snake Pond. Negotiations began 6 September 1996 with the property owner to obtain the necessary access to construct and operate the system.

2.2 PROJECT ISSUES

The following issues will require actions and resolution in order to complete the successful installation and operation of the FS-12 plume containment system:

1) After reviewing the reports submitted thus far, regulatory staff have requested additional detail describing the basis and the appropriateness of the proposed ETR system.

2) The ultraviolet oxidation (UVO) and GAC processes used to remove the contaminants (i.e., principally benzene and EDB) from the groundwater will also remove the dissolved oxygen and some trace elements. To avoid potential adverse impacts on the ecology, it is expected that the treatment process will require equipment to replenish the dissolved oxygen concentration in the effluent stream. The dissolved oxygen concentration required in the effluent stream has not yet been established. The potential ecological impacts of other physical or chemical parameters (for example, pH, temperature, total organic carbon, metals, etc.) is also being investigated.

3) Potential constraints related to property access are significant. The CGN property owner expressed a desire for the relocation of a significant portion of the reinjection well network. Relocation would require a resimulation of the plume and a reassessment of the proposed extraction and reinjection networks. A restricted construction season (in order to accommodate summer camp activities from mid-June through Labor Day) may impact the system startup date.

4) As in any evaluation of groundwater cleanup options, the variability of aquifer and plume characteristics found in nature introduces uncertainties into the assessment process. The accuracy of model predictions can be affected by many factors, including:

- variations of hydraulic conductivity;
- lithology variations;
- pond-groundwater interconnection;
- future pumping from other wells;
- the accuracy of the plume representation incorporated in the model;

2.3 PLANNED ACTIONS

The following actions are planned to address the issues identified above.

1) A meeting will be held in late September to provide a more detailed explanation of the basis for the proposed ETR system for the regulatory staff.

2) The effluent criteria with respect to protection of the ecological receptors will be defined through continued interaction with the Technical Review and Evaluation Team (TRET), regulatory staff, and AFCEE personnel. If necessary, sampling of existing background wells to establish ambient criteria will be performed. The plume contaminants (principally EDB and benzene) will be removed to below the detection limits as defined in analytical Methods USEPA 504 and Modified 8020, respectively.

3) Access requirements will be identified by the Jacobs design team. The Army Corps of Engineers (COE) has the responsibility to negotiate, for AFCEE, all access for non-MMR properties.

Property access issues will be addressed through two methods. Additional simulation runs will be made to determine if the ETR network can be rearranged to address property owner preferences, while maintaining acceptable capture and containment performance without adverse impact to Snake Pond or other sensitive habitats. These efforts will be coordinated with the TRET and AFCEE. Jacobs will also consider alternative construction methods (buried vaults, for example) to develop a plan that is acceptable to the property owner.

Jacobs will evaluate the potential for shortening the construction schedule to avoid possible conflicts during the June 25 to Labor day time interval through fast-tracking and/or early starts on key activities. The final resolution of the issue is partly dependent on whether or not the ETR network is revised. An assessment of the feasibility of maintaining the schedule for the planned system startup during this interval (currently at 27 August 1997) will be prepared.

4) To compensate for model prediction uncertainties, additional groundwater and soil (lithologic) sampling will be performed during the installation of the extraction and

injection well network to further refine plume definition and lithology. This information will be used to verify assumptions made during modeling of the ETR scheme. Portions of the performance monitoring well network or additional investigation wells may also be constructed early for this purpose. In addition, pump tests will be conducted to confirm hydrogeologic parameters (e.g., hydraulic conductivity) used to develop the containment strategy. If these parameters are substantially different from those assumed during ETR modeling, additional simulations may be performed to recalibrate the model and further refine well spacing and pumping rates. Sampling of existing monitoring wells will also be conducted to determine if plume migration has advanced beyond the proposed ETR fence.

2.4 PROJECT DELIVERABLES

Major deliverables include this Draft Project Execution Plan and the Draft Design Submittal.

The Draft Design Submittal will consist of a three volume report. Volume I is text only which will include:

- Basis of Design (will include summary of any additional modeling results and proposed effluent chemical parameters);
- Rationale and Description of Treatment Process;
- Description, Sizing and Layout for Key System Components;
- Rationale and Description for Extraction and Reinjection Systems; and
- Operational Philosophy including Rationale and Description of Operating Safeguards.

Volume II will be drawings only, 11" x 17", which will include:

- Process Flow Diagrams, (PFDs);
- Piping & Instrumentation Diagrams, (P&IDs);
- Treatment Facility Equipment Layout;

- Location of Treatment Facilities, Extraction and Reinjection Wells; and
- Exterior Building Elevations.

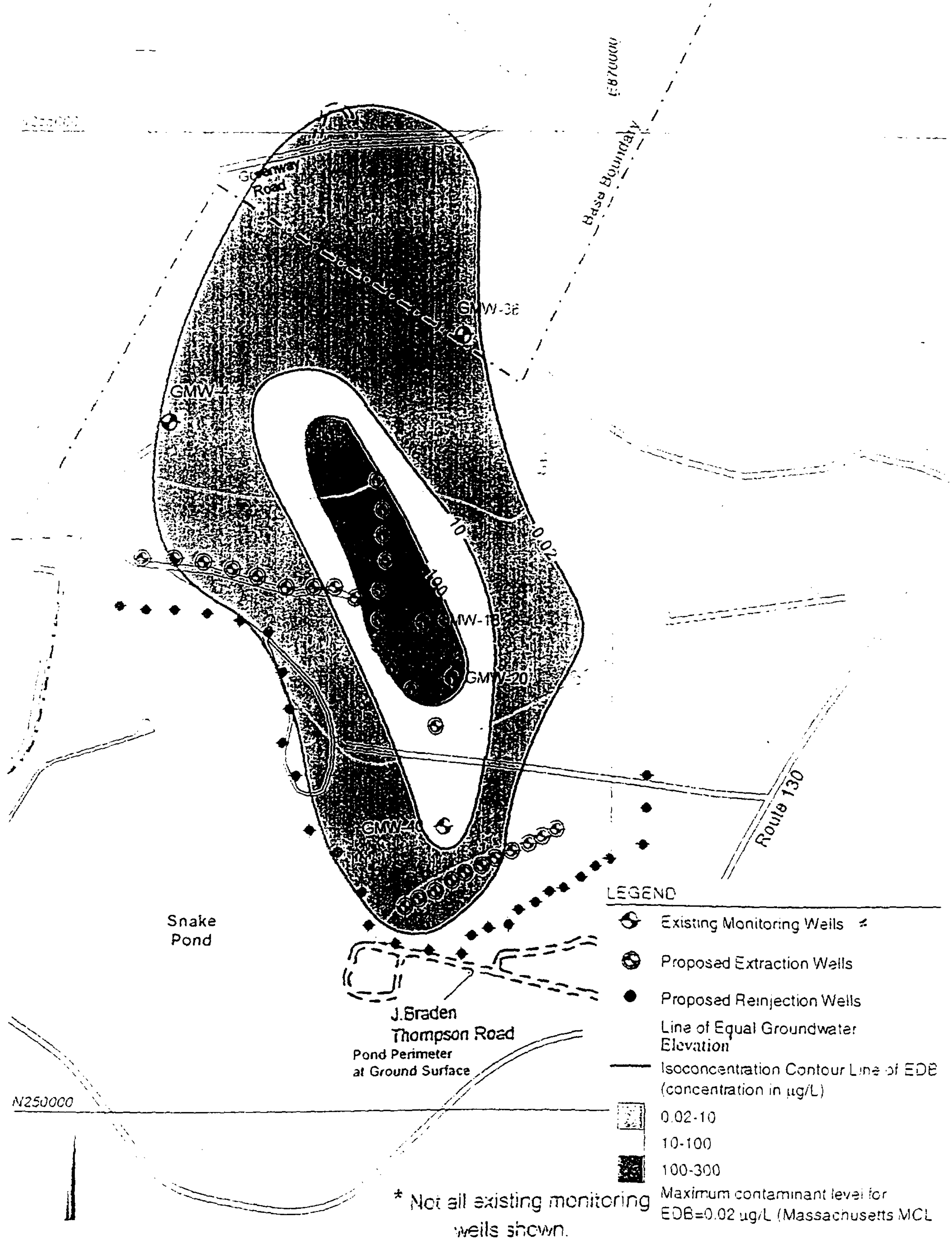
Volume III will include the specifications for major equipment. This volume will be distributed only to the U.S. Environmental Protection Agency (EPA) and Massachusetts DEP unless otherwise directed.

2.5 SCHEDULE

The schedule for the engineering and construction activities for the FS-12 containment system is shown in Figure 2-3.

Activities proposed as enforceable milestones are:

Draft Execution Plan	September 9, 1996
Draft Design (FS-12 Treatment System)	October 21, 1996
Construct Foundation For Treatment System Building and Six Extraction or Reinjection Wells	April 29, 1997
System Startup	August 27, 1997



FUEL SPILL 12
LOCATION OF PROPOSED EXTRACTION AND REINJECTION WELLS AND EDB MCL EXCEEDANCE

Massachusetts Military Reservation
Cape Cod, Massachusetts

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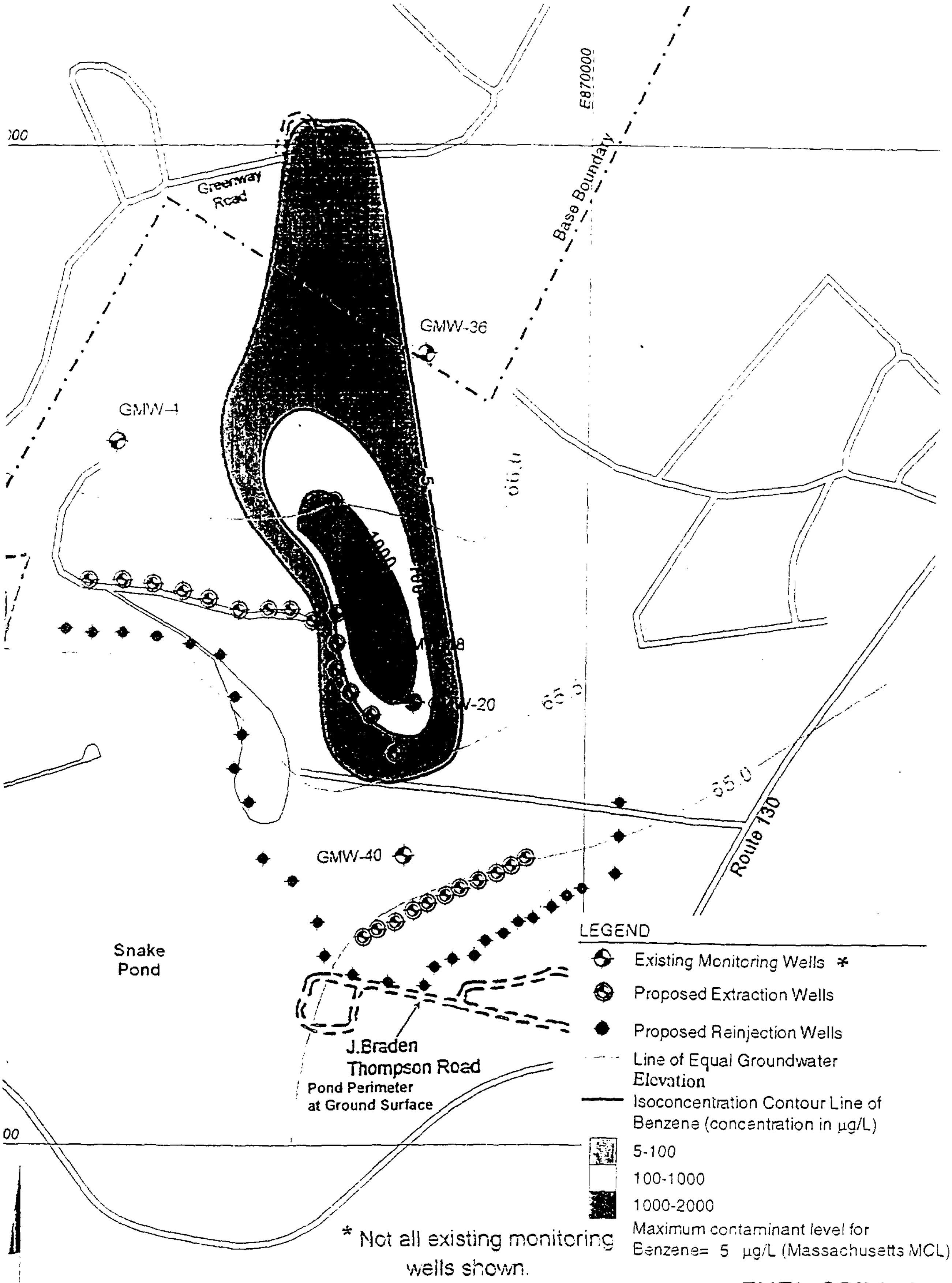
FIGURE 2-1



FUEL SPILL 12
LOCATION OF PROPOSED EXTRACTION AND REINJECTION WELLS AND BENZENE MCL EXCEEDANCE

Massachusetts Military Reservation

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FIGURE 2-2

Activity ID	Activity Description	Orig Dur	Early start	Early finish
35-K784-04 FS-12 CONTAINMENT SYSTEM				
PLANS				
AD0505	Receive Pumping Rates & Well Locations	1	15JUL96	15JUL96
AD0510	Draft Execution Plans	40	16JUL96	10SEP96
AD0512	Submit Draft Execution Plans	0		10SEP96
AD0520	DOD, Reg & Pub Rev of Draft Exec. Plans	10	11SEP96	24SEP96
AD0530	Prepare Final Execution Plans & Submit	20	25SEP96	22OCT9
DESIGN				
AD1010A	Design - Houston	86*	16JUL96	27AUG9
AD1012	Draft Design - Treatment System	70	16JUL96	22OCT9
AD1014	Submit Draft Design - Treatment System	0		22OCT9
AD1020	DOD, Reg & Pub Rev of Draft Design - Treat Syst	10	23OCT9	05NOV9
AD1030	Prepare Final Design - Treatment System	54	06NOV9	24JAN97
AD1031	Review/Finalize Final Design - Treatment System	11	10JAN97	24JAN97
AD1032	Submit Final Design - Treatment System	1	27JAN97	27JAN97
AD1033	Prodeed with Approved Design Effort	151	28JAN97	27AUG9

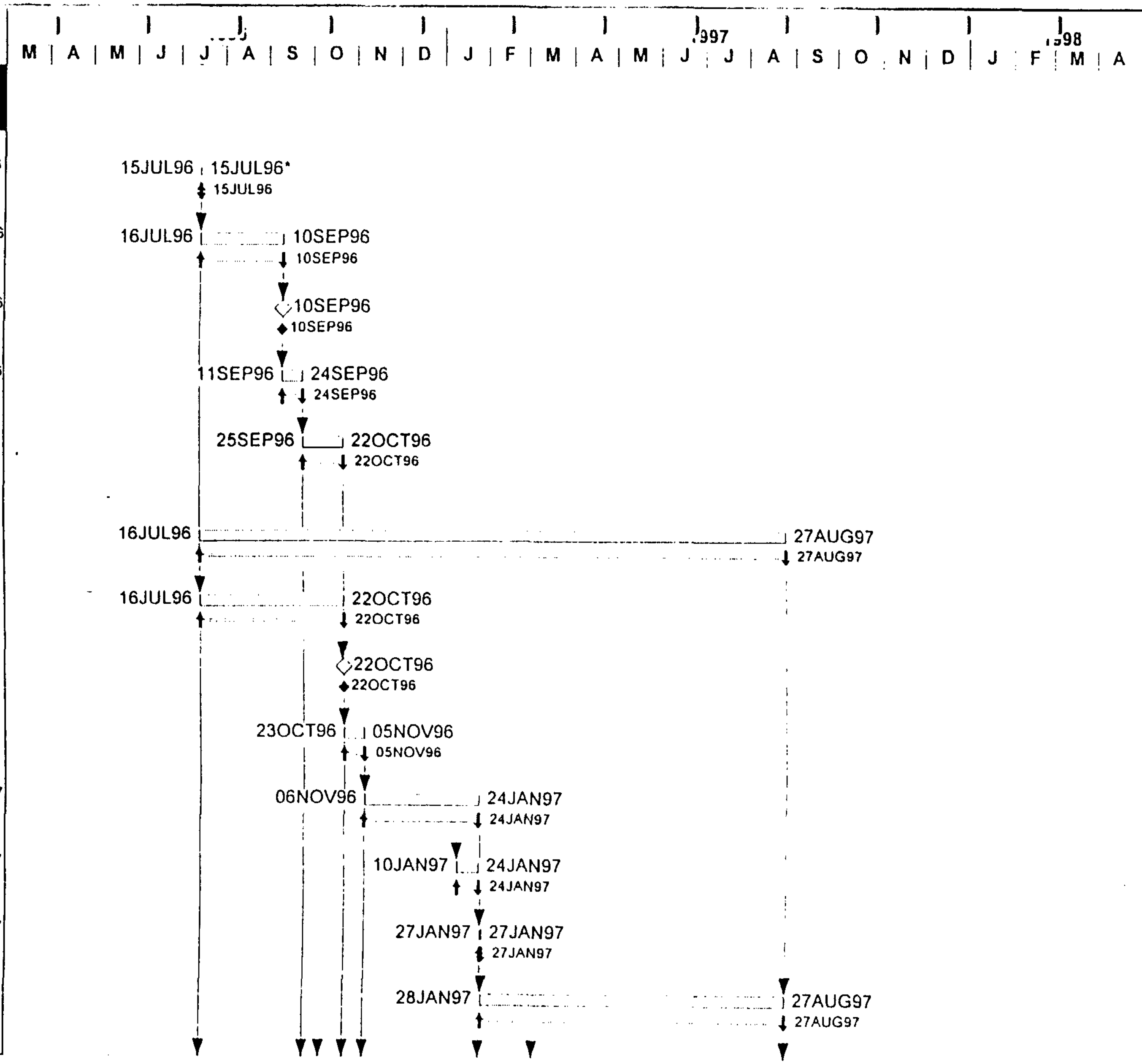
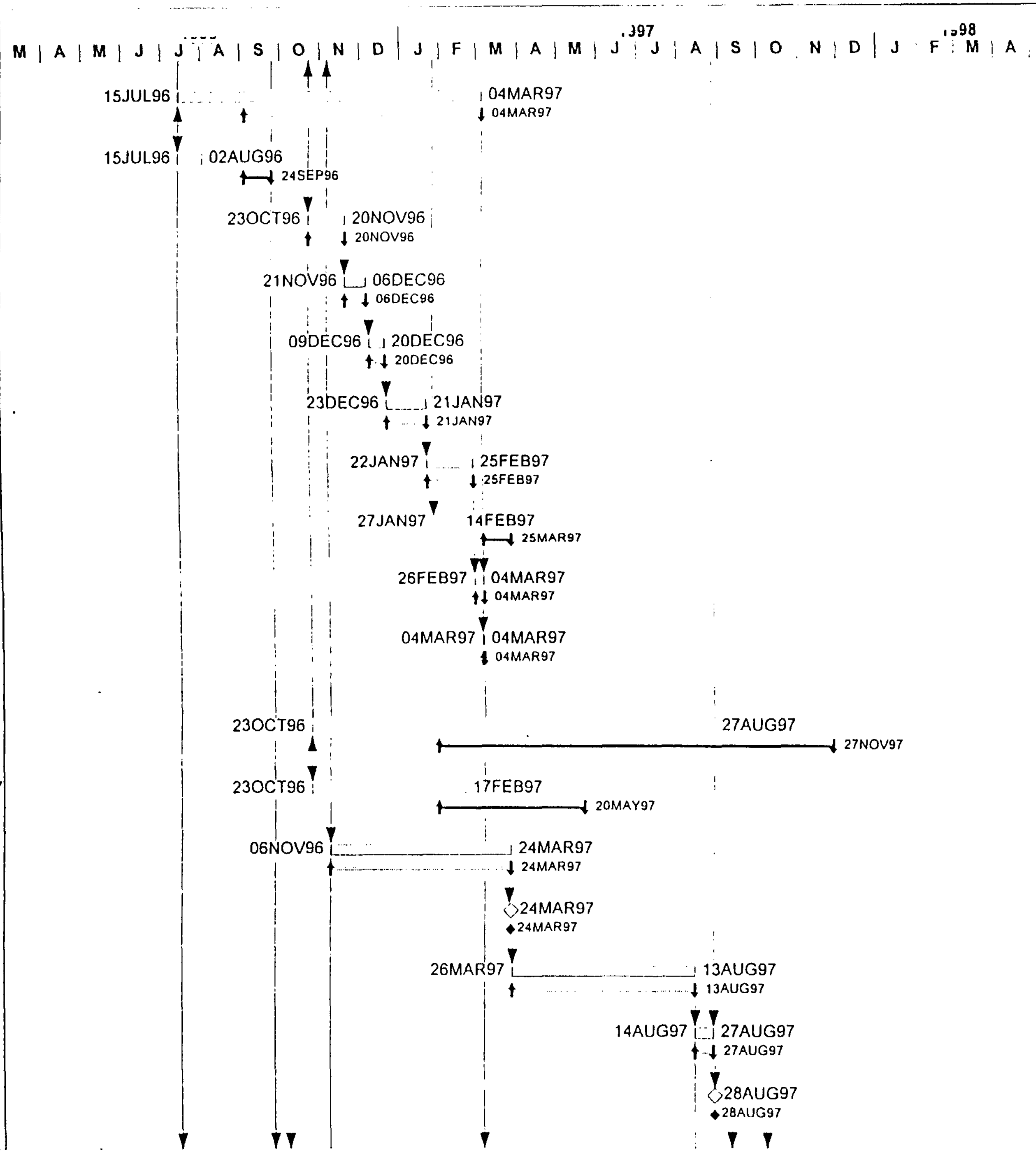


Figure 2-3 FS-12 Containment Systems Schedule

Activity ID	Activity Description	Orig Dur	Early start	Early finish
ACCESS/PERMITS				
AD1501	Property Access	62*	15JUL96	04MAR9
AD1515	Site Access - Preliminary Field Work	15	15JUL96	02AUG9
AD1535	Final Siting/Boundary Survey	21	23OCT9	20NOV9
AD1545	Legal Description	10	21NOV9	06DEC9
AD1555	Real Estate Segment Map	10	09DEC9	20DEC9
AD1565	Title Evidence/Appraisal	20	23DEC9	21JAN97
AD1585	Negotiations/Purchase Options	25	22JAN97	25FEB97
AD1530	Construction Permits	15	27JAN97	14FEB97
AD1595	Closing	5	26FEB97	04MAR9
AD1540	Site Access Approval	1	04MAR9	04MAR9
CONSTRUCTION				
AD2001	Construction	16*	23OCT9	27AUG9
AD2010	Order/Delivery of Major & Specialty Items	80	23OCT9	17FEB97
AD2019	Initial Const. (foundation/support facilities)	95	06NOV9	24MAR9
AD2002	Complete Foundation & 6 Wells (Milestone)	0		24MAR9
AD2020	Install Treatment System	100	26MAR9	13AUG9
AD2030	Test System	10	14AUG9	27AUG9
AD2050	System Startup	0		28AUG9



Activity ID	Activity Description	Dur	Early start	Early finish
DRILLING/TESTING				
AD2501	Drilling	61*	16JUL96	23JUL97
AD2510	Reinjection Test (inc. Well Drilling)	58	16JUL96	04OCT9
AD2512	Prelim Field Work - Geotech	35	25SEP96	12NOV9
AD2520	Drill Extraction/Injection/Monitoring Wells	100	05MAR9	23JUL97
SAMPLING/ANALYSIS/DATA MGMT				
AD3001	Sampling	50*	24JUL97	01OCT9
AD3004	Data Management/Chemistry	00*	24JUL97	10DEC9
AD3010	Baseline Groundwater Sampling	15	24JUL97	13AUG9
AD3012	Baseline Groundwater Data Mgmt/Chemistry	54	24JUL97	07OCT9
AD3020	Operational Monitoring (1)	15	11SEP97	01OCT9
AD3022	Operational Monitoring (2)	15	16OCT9	05NOV9
AD3024	Operational Monitoring (3)	15	20NOV9	10DEC9
REPORTS				
AD3510	Prepare Tech Report-System Startup & Testing	30	08OCT9	18NOV9
MODELING				
AD4501	Modeling Budget	22	07OCT9	05NOV9

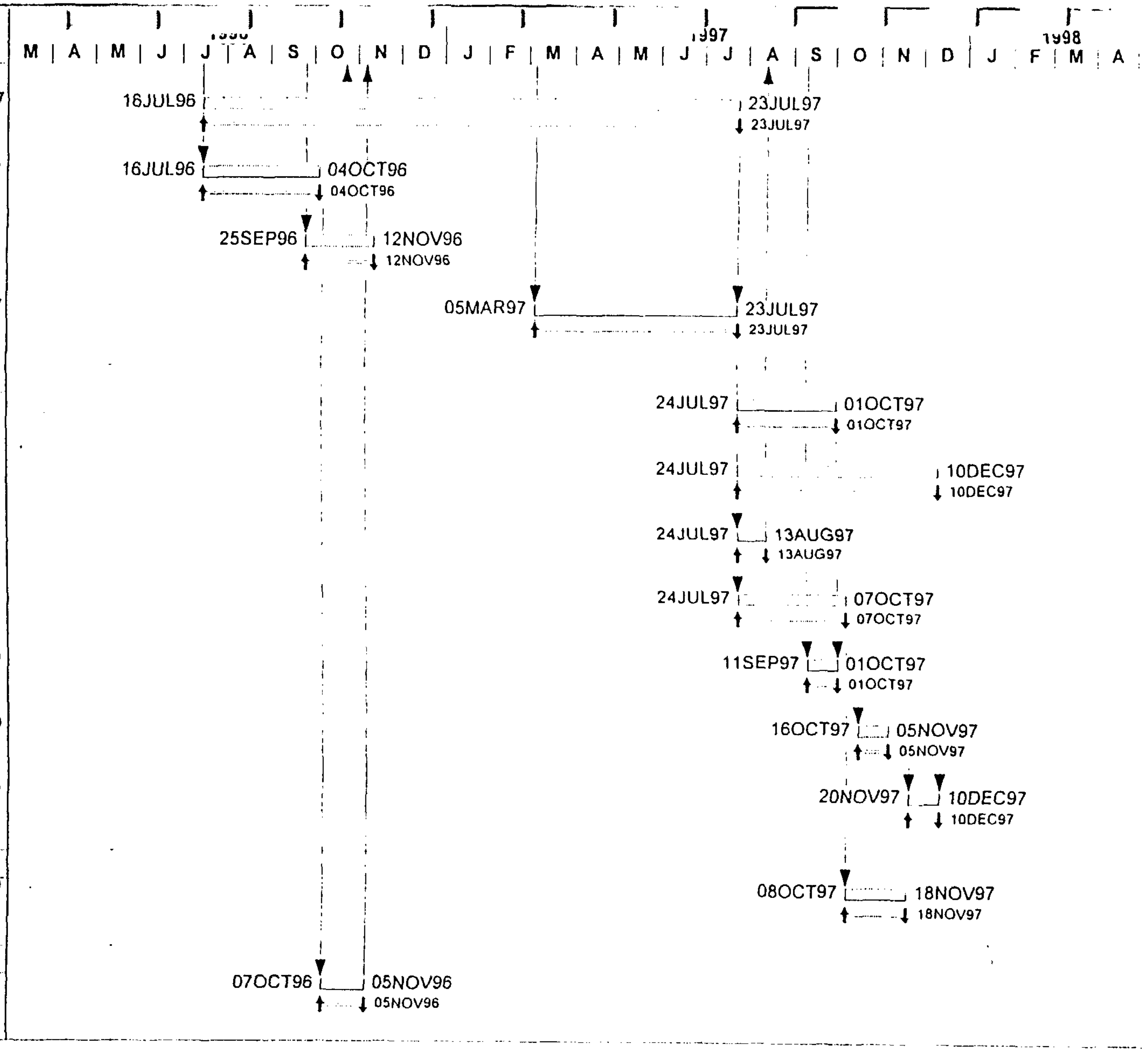


TABLE 2-1
FS-12 EXTRACTION/REINJECTION WELLS

North Reinjection Wells (226.38 gpm)

Northing (coordinates)	Easting (coordinates)	Top of Screen (ft msl)	Bottom of Screen (ft msl)	Pump Rate (gpm)
867150	252140	30	-30	37.73
867290	252120	30	-30	37.73
867450	252120	30	-30	37.73
867630	252100	30	-30	37.73
867810	252060	30	-30	37.73
867970	252000	30	-30	37.73

Central Reinjection Wells (415.6 gpm)

Northing (coordinates)	Easting (coordinates)	Top of Screen (ft msl)	Bottom of Screen (ft msl)	Pump Rate (gpm)
868050	251780	30	-30	39.30
868090	251580	30	-30	50.00
868050	251400	30	-30	60.00
868130	251220	30	-30	70.00
868210	250920	30	-30	60.00
868370	250800	30	-30	60.00
868510	250580	30	-30	40.00
868550	250400	30	-30	36.30

Toe Reinjection Wells (185.52 gpm)

Northing (coordinates)	Easting (coordinates)	Top of Screen (ft msl)	Bottom of Screen (ft msl)	Pump Rate (gpm)
868710	250300	5	-60	9.50
868910	250260	5	-60	10.00
869110	250240	5	-60	10.50
869170	250340	5	-60	10.50
869270	250380	5	-60	10.50
869390	250400	5	-60	10.50
869450	250480	5	-60	10.50
869550	250520	5	-60	10.52
869630	250580	5	-60	12.00
869710	250600	5	-60	13.00
869810	250660	5	-60	14.00
869890	250720	5	-60	15.00
869970	250760	5	-60	16.00
870150	250840	5	-60	12.00
870170	251040	5	-60	11.00
870170	251220	5	-60	10.00

TABLE 2-1, continued

North Axial Extraction Wells (-97.5 gpm)

Northing (coordinates)	Easting (coordinates)	Top of Screen (ft msl)	Bottom of Screen (ft msl)	Pump Rate (gpm)
868590	252820	5	-60	-22.50
868630	252660	5	-60	-22.50
868630	252520	5	-60	-22.50
868650	252380	5	-60	-30.00

West Axial Extraction Wells (-310 gpm)

Northing (coordinates)	Easting (coordinates)	Top of Screen (ft msl)	Bottom of Screen (ft msl)	Pump Rate (gpm)
867270	252400	5	-60	-35.00
867450	252400	5	-60	-30.00
867610	252380	5	-60	-30.00
867770	252340	5	-60	-30.00
867910	252300	5	-60	-35.00
868070	252240	5	-60	-35.00
868230	252240	5	-60	-35.00
868350	252240	5	-60	-40.00
868470	252180	5	-60	-40.00

South Axial Extraction Wells (-155 gpm)

Northing (coordinates)	Easting (coordinates)	Top of Screen (ft msl)	Bottom of Screen (ft msl)	Pump Rate (gpm)
868610	252220	5	-60	-25.00
868610	252060	5	-60	-25.00
868610	251920	5	-60	-25.00
868690	251800	5	-60	-25.00
868810	251680	5	-60	-25.00
868950	251480	5	-60	-30.00

Toe Axial Extraction Wells (-255 gpm)

Northing (coordinates)	Easting (coordinates)	Top of Screen (ft msl)	Bottom of Screen (ft msl)	Pump Rate (gpm)
868770	250500	5	-60	-25.00
868850	250540	5	-60	-25.00
868950	250580	5	-60	-25.00
869050	250640	5	-60	-25.00
869130	250680	5	-60	-20.00
869230	250720	5	-60	-25.00
869310	250760	5	-60	-20.00
869410	250800	5	-60	-25.00
869510	250840	5	-60	-25.00
869590	250880	5	-60	-25.00
869670	250920	5	-60	-25.00

Notes:

ft msl feet mean sea level
gpm gallons per minute

3.0 DESIGN APPROACH

Execution of the design, engineering, construction, operation will be based on the following overall strategy:

1) Perform additional site-specific investigations (sampling and drilling as described in Section 4.3) in advance of construction to better define the horizontal and vertical extent of the FS-12 plume. This information will be used to refine screen elevations in the extraction well network and confirm the plume definition that was used in the model simulations of ETR effectiveness.

2) Provide flexibility in the operating range of the ETR system to enable adaptation of future operation in response to information gained as remediation progresses. The treatment plant has been designed so that it can be operated over a wide range of throughput (+30%, -50% of the design flow). This strategy allows for design uncertainties and potential future changes in required pumping rates.

3) Incorporate additional data collection into early construction efforts (described in Section 4.3.2).

4) Review data (collected in Step 3) concurrently with the construction effort to identify any significant differences from the design assumptions or aquifer characteristics assumed during the modeling of alternatives. If significant differences are found, it may be necessary to revise the design and/or construction in response to such findings.

5) Develop a performance monitoring evaluation system that will provide data to show the effectiveness of containment, capture, and treatment, and indicate progress towards attaining cleanup goals (this topic is discussed in Section 5.0).

3.1 DESIGN BASIS FOR THE FS-12 ETR SYSTEM

The FS-12 ETR system has a number of objectives which include (Strategic Plan AFCEE, 1996)

- Design, construct, and operate a full-scale ETR system.
- Contain, capture, and remediate the FS-12 plume.
- Minimize adverse impacts on Snake Pond and its surrounding environment.
- Monitor performance of treatment system.
- Avoid influencing the remedial system on the J. Braden Thompson plume.
- Minimize disturbance to private property.
- Monitor groundwater quality to assess performance and assist future design at other sites.

3.1.1 FS-12 Geology

Geologic interpretations of the FS-12 Study Area are based on soil sampling of both the unsaturated and saturated zones, boring log data obtained from split-spoon samples, auger cuttings, and variations in drill rates.

A zone of surface and weathered residual soil of approximately 2 to 5 feet is common in the study area. The interval typically consists of yellowish-brown to dark-brown horizons of silty clay or clayey silt, with variable mixtures of fine sand and/or organic matter.

Underlying the soil zone is the upper sand and gravel outwash deposits of the Mashpee Pitted Plain (ASI 1995). The substrata are unconsolidated and typically consist of light-brown or yellowish-orange-brown sand with minor amounts of gravel, and little to no fines (silt and clay). The sand is mostly weathered quartz with some feldspar. The grains are typically well-sorted, predominantly medium-grained, and sub-angular to sub-rounded. Trace amounts of weathered micas (muscovite and biotite) and hornblende may be present. The gravel component typically ranges

between 0 to 25 percent of the lithology. It is typically poorly sorted with clasts ranging in size from fine gravel to cobbles or boulders. The clasts are predominantly weathered granite (ASI 1995).

Locally, an abundance of coarse gravel (cobbles to boulders) is common in the uppermost 30 feet of substrata. Discontinuous zones of gravel may occur throughout the outwash deposits. The sands and gravels generally lack cementation between sediment grains. This is commonly exhibited by the occurrence of flowing or "heaving" sands below the water table. Porosities typically range from 30 to 40 percent (Leblanc 1984). The overall Unified Soil Classification System (USCS) designation for the deposits is SP: poorly-graded sand or gravely sand with little or no fines. The deposits are typical of high-energy fluvial environments, distinctive of pro-glacial outwash plains.

Below the uppermost 130 feet of sand and gravel deposits, intervals of fine-grained glaciolacustrine sediments were noted, particularly at depths ranging between approximately 130 to 215 feet below ground surface (bgs) (i.e., +20 to –65 feet MSL). Bedrock was not encountered during drilling activities at FS-12. Several borings penetrated approximately 20 to 25 feet of dense deposits of fine sand and slit. These sediments typically consist of gray to brownish-gray silty to sandy clay, clayey silt and sand, or silty sand. The deposits are indicative of restricted, low-energy glaciolacustrine environments. Geologic sections A-A' and B-B' (Figures 1-5 and 3-1) exhibit the lithology and geometry of the soil units underlying FS-12.

3.1.2 FS-12 Hydrogeology

The total thickness of the saturated zone in the study area is estimated to be in excess of 200 feet. Penetration by auger drilling was limited to the uppermost 210 feet. The occurrence of low-permeability, fine-grained deposits within the aquifer indicate the existence of vertical and horizontal heterogeneity and therefore anisotropic flow conditions.

Groundwater in the study area is unconfined, with an average depth to groundwater of 70 feet. The water table is exposed at the surface in Snake Pond, delineating the southwestern boundary of the FS-12 area. The general direction of groundwater flow appears to shift slightly with seasonal fluctuations in aquifer recharge; however, the groundwater generally flows south to southeast. Groundwater elevation contour at FS-12 is included in Figures 1-3 and 1-4. The horizontal flow gradient generally ranges from 0.00025 to 0.0006 foot per foot (ft/ft). During the late summer or early fall, groundwater enters Snake Pond from the northwest, north, and northeastern sides. During the spring, groundwater inflow to the pond appears to be predominantly from the northwest and north.

One of the man-made features affecting the water table elevations in the southwest corner of the study area is the SWD Weeks Pond Well No. 5. The pumping rates for the Weeks Pond Well are normally 700 gallons per minute (gpm) for 6 hours each day; however, the duration of pumping is adjusted as needed to meet water usage demands (higher in summer). Final groundwater modeling simulations performed for FS-12 included the Weeks Pond well operating at 700 gpm to ensure that the ETR system would still achieve plume capture objectives during peak water demand periods.

Vertical gradients were calculated from seven sets of cluster wells at the site. Well clusters located between 100 and 800 feet (predominantly northeast) from Snake Pond all showed slight upward vertical gradients ranging from 0.0002 to 0.006 ft/ft (ASI 1995). Well clusters located between 1,050 and 1,520 feet (predominantly northeast) from Snake Pond all showed slight downward gradients ranging from 0.001 to 0.002 ft/ft (ASI 1995).

A series of injection and pumping tests were performed at FS-12 to aid in the Remedial Design:

1) Advanced Sciences, Inc. (ASI) and Hydrogeologic conducted a 72-hour pump test at the FS-12 study area in December 1993. The pumped well was approximately 740 feet northeast of monitoring well GMW-47. The overall horizontal hydraulic conductivity for the aquifer ranged from approximately 240 to 370 feet per day (ft/day), with an average of 320 ft/day. Vertical hydraulic conductivity ranged from 15 to 190 ft/day, with an average of approximately 75 ft/day. Specific yield ranged from 0.8 to 18.4 percent, with an average of 9 percent. Transmissivity ranged from 26,000 to 40,000 square feet per day (ft2/day), with an average of 35,000 ft2/day.

2) A pumping step-test, injection step-test, 72-hour constant rate simultaneous injection/extraction test (and recovery period) and post-injection step-test were performed immediately northwest of Snake Pond. The purpose of these tests were to evaluate aquifer response to simultaneous extraction and injection adjacent to the pond with particular interest in the degree of groundwater table mounding created at the injection well site.

3) In addition, a step injection test was recently conducted southwest of Snake Pond to evaluate short-term aquifer response and specific injectivity and to determine if there are significant differences in aquifer characteristics across the FS-12 study area. Preliminary results from this test will be available in late September 1996.

3.1.3 FS-12 Modeling

The main objectives of the groundwater containment modeling of FS-12 are as follows, in order of importance (OpTech, 1996):

- Maximize contaminant capture of the FS-12 plume, protecting downgradient receptors with containment wells toward the leading edges of the plume and achieving mass reduction by installing additional wells in areas of higher contaminant concentrations.
- Minimize hydrologic impacts on nearby surface water (mainly Snake Pond).
- Minimize influence on movement of the J. Braden Thompson plume.

- Emphasize constructability and minimize impact to surrounding land.
- Minimize recapture of injected, treated groundwater.
- Minimize pumping rates.

These criteria were considered during modeling efforts to achieve a balance between the objectives.

In order to identify an efficient ETR system that satisfies the established design criteria, groundwater modeling was conducted using the code FRAC3DVS (Therrien, R. et al., 1994). Hydraulic conductivity values used for FS-12 modeling were developed from aquifer pump and slug testing and adjusted during model calibration to obtain an acceptable match between modeled and observed groundwater elevations and stream flow measurements. To provide an additional model check, particle tracking was also performed to help evaluate if the model accurately predicted the rate and direction of plume migration over time. Modeling details are provided in OpTech, 1996b.

Following model construction and calibration, fifteen different ETR schemes were developed and evaluated. The percent of contaminant mass captured and water table drawdown were two critical evaluation criteria for the alternatives assessed by the model. Based on the modeling results, Well Scheme 15 provided the best balance of maximizing plume capture while minimizing aquifer drawdown and impact to Snake Pond. Well Scheme 15 consists of 30 extraction wells pumping at a design rate of 828 GPM, and 30 injection wells pumping the same volume back into the aquifer following treatment.

3.2 DESIGN METHODOLOGY

Detailed engineering is based upon the PFDs (Figure 3-2 and 3-3) that provide the material balance, including concentrations of contaminants, for the groundwater that is being extracted, treated, and reinjected. The treatment process for the extracted

groundwater consists of greensand filters to remove heavy metals, followed by UVO treatment, and granular activated carbon (GAC) absorption filters. The UVO and GAC steps will remove EDB, hydrocarbons and residual contamination. Holding, equalization and backwash tanks, pumps, pH control, and other ancillary systems are shown in the PFDs. Dissolved oxygen in the effluent will be restored to approximately 5 to 10 mg/L (the equipment to add oxygen is not shown on these figures but will be presented in the Draft Design Submittal). If performance monitoring identifies detrimental chemical changes in the groundwater, additional treatment may be required and will be added at that time.

Detailed discussion on the selection, sizing and operational philosophy will be presented in the Draft Design Submittal. The Draft Design Submittal will be issued for regulatory review and comment. The Draft Design Submittal will also be available to the TRET, and the Joint Process Action Team (JPAT) for comment. Figure 3-4 illustrates the review and participant involvement during the project. The final design drawings will be used by the contractor(s) who construct the system, and will be issued to others for information only.

The treatment system will be designed for year-round operation with minimal operational support. The design will be based upon the American National Standards Institute (ANSI), the American Water Works Association (AWWA), the American Society of Mechanical Engineers (ASME), and the American Society of Testing and Materials (ASTM) standards and local codes. Jacobs will review constructability of the engineering design on an ongoing basis to ensure efficient and economical construction and operation.

3.3 PROCUREMENT INTERFACE

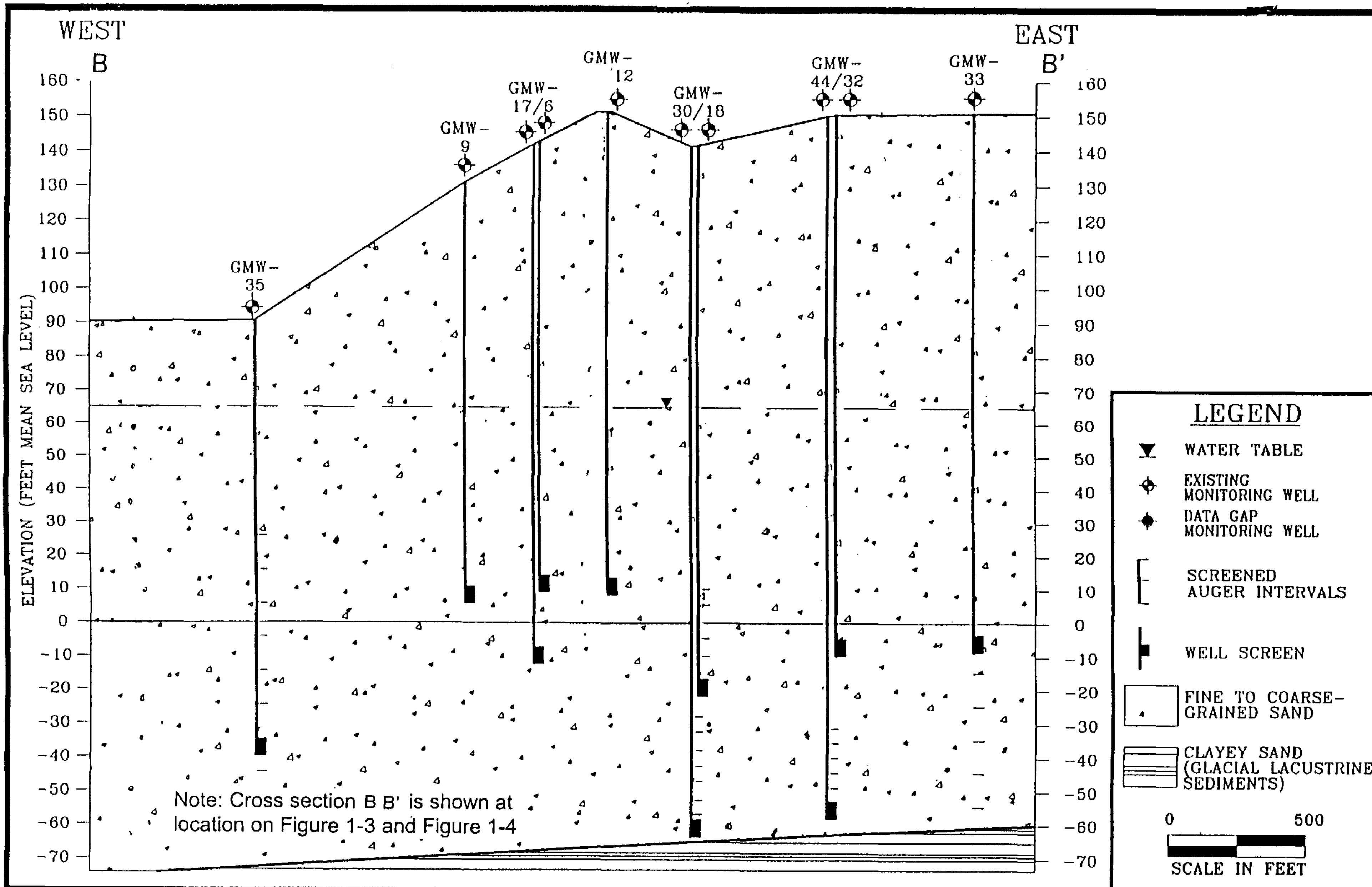
Jacobs will prepare bid packages and equipment specifications for the procurement and construction of the FS-12 system. The design team and construction management staff will provide input to the contracts/purchasing manager in the selection of the

vendors and subcontractors. The design team will also review vendor drawings and in conjunction with the construction management group will recommend, recommend with conditions, or reject vendor drawings and packages. If the selection of a vendor or subcontractor results in a design change, upon approval from AFCEE, the design team will make the necessary changes to the engineering drawings.

Subcontracts may be let for the following segments of the treatment system:

- construction of the treatment facility;
- procurement of materials and equipment not provided by Jacobs (bulk and commodity items);
- temporary field offices and storage for subcontractor use;
- site preparation for the treatment facility;
- installation of foundations, slabs, and parking areas;
- utility tie-ins including sewage, water, and electric/power;
- procurement and erection of pre-engineered building and installation of interior electrical and HVAC systems;
- installation of power and control wiring, connection of power, water, and process piping to sub-ups adjacent to the building;
- installation of paving, curbing, and landscaping around the treatment system facility; and
- restoration and landscaping.

Procurement will be in accordance with the Federal Acquisition Records (FARs). Bidders lists will be developed from input by engineering and construction. The use of local vendor representatives and local/small business contractors will be emphasized.



OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

FEBRUARY 1996

HYDROGEOLOGIC CROSS-SECTION B-B'
AT FUEL SPILL-12
Massachusetts Military Reservation
Cape Cod, Massachusetts

FIGURE 3-1

OTIS\FLDW-219\FS-12-C

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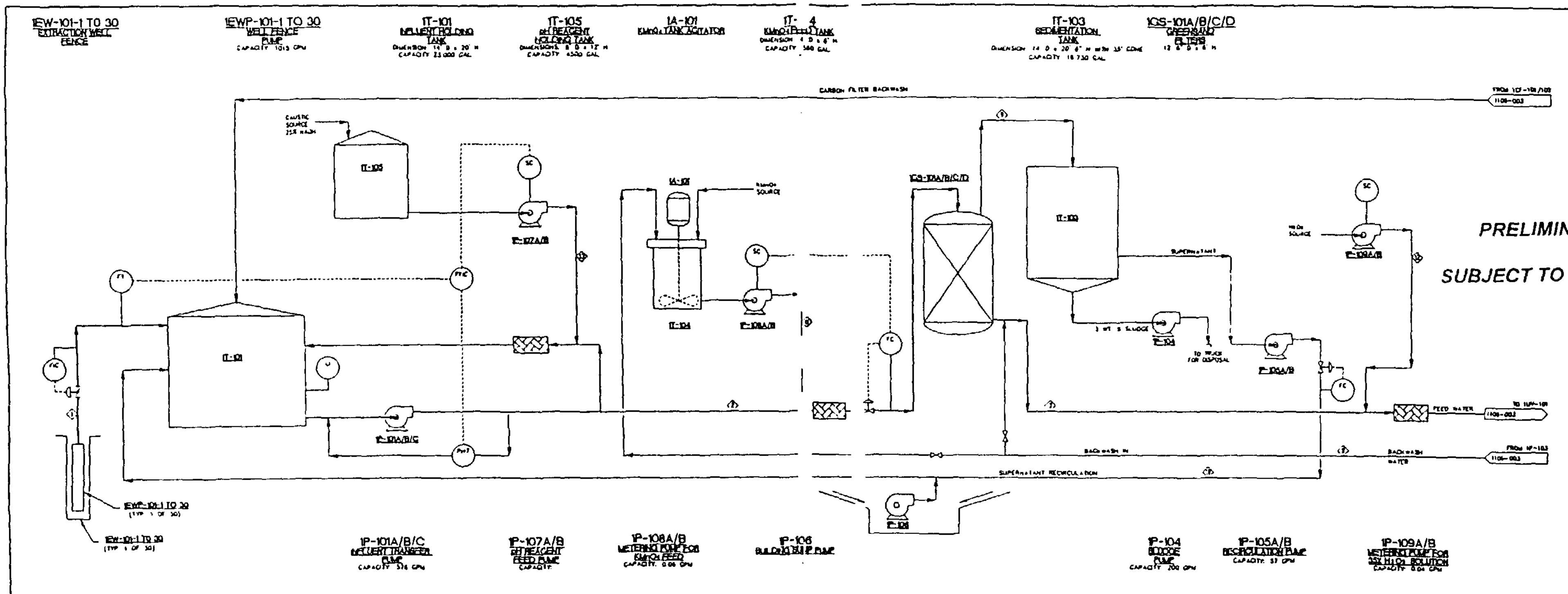

COMPONENTS	MOLEC. WEIGHT	INFLUENT CONC. (ug/l)	EFFLUENT CONC. (ug/l)	STREAM NUMBER	1	2	3	4	5	6
				STREAM NAME	INFLUENT WATER	INFLUENT TANK DISCHARGE	GREENSAND FILTER EFFLUENT	UV/OXIDATION EFFLUENT	CARBON ADSORBERS EFFLUENT	TO REINJECTION WELLS
						NOTE 9	NOTE 1,2		NOTE 3,4	
WATER	18	—	—	LBS/HR	508,008	528,022	528,022	528,022	528,022	508,008
POTASSIUM PERMANGANATE	158	—	—	LBS/HR	0	0	0	0	0	0
HYDROGEN PEROXIDE	34	—	—	LBS/HR	0	0	0	0	0	0
SODIUM HYDROXIDE	40	—	—	LBS/HR	0	0	0	0	0	0
EDB	188	0.2	ND	LBS/HR	4.17E-03	4.31E-03	4.31E-03	2.88E-03	ND	ND
BENZENE	78	60	ND	LBS/HR	3.03E-02	3.16E-02	3.16E-02	3.16E-03	ND	ND
TOC	NOTE 7			LBS/HR						
MANGANESE	55	65	6.5	LBS/HR	3.30E-02	3.43E-02	3.43E-03	3.43E-03	3.43E-03	3.30E-03
IRON	56	328	33	LBS/HR	2.87E-01	2.77E-01	2.71E-02	2.71E-02	2.71E-02	2.68E-02
TOTAL SUSPENDED SOLIDS	NOTE 8	2500	2.5	LBS/HR	1.27E+00	1.33E+00	1.32E-01	1.32E-01	1.32E-03	1.27E-03
FLOW BASIS 24 HRS/DAY DAYS PER YEAR=365				TOTAL LBS/HR	508,010.43	528,028.53	528,027.07	528,027.04	528,026.88	508,008.86
				FLOW GPM	1,015	1,084	1,081	1,081	1,081	1,015
				FLOW SCFM	-	-	-	-	-	-
				TEMPERATURE, F	55	55	55	56	55	56
				pH						
				PRESSURE, PSIG						
				VISCOSITY AT TEMP CP	1.0	1.0		1.0	1.0	1.0
				DENSITY, LB/FT^3	62.40	62.40	62.40	62.40	62.40	62.40
				PHASE	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID

STREAM NUMBER	7	8	9	10	11	12	13
STREAM NAME	CARBON ADSORB. BACKWASH WATER	GREENSANDS BACKWASH WATER	GREENSANDS BACKWASH EFFLUENT	SUPERNATANT FILTRATE RECIRCULATION	KMnO4 INJECTION	HYDROGEN PEROXIDE INJECTION	NaOH ADDITION
	NOTE 5	NOTE 5,6	NOTE 5,6	NOTE 10			
WATER (LBS/HR)	500,501	570,571	570,571	28,528.57	29.40	15.20	10.40
POTASSIUM PERMANGANATE (LBS/HR)	-	0	0	0	0.80	0	0
HYDROGEN PEROXIDE (LBS/HR)	-	0	0	0	0	7.31	0
SODIUM HYDROXIDE (LBS/HR)	-	0	0	0	0	0	3.50
EDB (LBS/HR)	ND	ND	ND	ND	ND	ND	0
BENZENE (LBS/HR)	ND	ND	ND	ND	ND	ND	0
TOC (LBS/HR)							
MANGANESE (LBS/HR)	2.73E	2.71E-03	1.56E+0	1.85E-04	2.02E-07	ND	0
IRON (LBS/HR)	2.65E	3.02E-02	1.48E+1	1.51E-03	1.65E-04	ND	0
TOTAL SUSPENDED SOLIDS (LBS/HR)	1.25E-[illegible]	1.43E-03	3.78E+1	7.13E-06	7.77E-06	ND	0
TOTAL LBS/HR	500,50[illegible]	570571.40	570586.59	28528.56	31.09	22.71	13.90
FLOW GPM	1	1,140	1,140	57	0.06	0.04	0.022
FLOW SCFM	-	-	-	-	-	-	-
TEMPERATURE, F	55	56	55	55	58	75	55
pH							
PRESSURE, PSIG							
VISCOSITY AT TEMP CP		1.0	1.0	1.0	1.0	1.0	1.0
DENSITY, LB/FT^3	6	62.40	62.40	62.40	62.40	73.2	73.25
PHASE	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID

NOTES:

1. FILTERED SOLIDS ACCUMULATE IN GREENSAND FILTERS AT A RATE OF 1.46 LB/HR.
2. ACCUMULATED PRECIPITATE SOLIDS ARE FILTERED AND DISPOSED OF DURING BACKWASH.
3. ADSORBENTS ACCUMULATE IN CARBON ADSORBERS AT A RATE OF 0.14 LB/HR.
4. ACCUMULATED ADSORBENTS ARE REMOVED BY ACTIVATED CARBON REPLACEMENT.
5. INTERMITTANT BACKWASH FLOW
6. EACH OF THE OPERATING GREENSAND FILTERS IS BACKWASHED ONCE PER DAY. THESE FLOWS ARE BASED ON A 15 MINUTE BACKWASH FLOW AT 1140 GPM.
7. TOC CONCENTRATION DATA HAS NOT BEEN MEASURED. IT WILL BE CONSIDERED WHEN DATA IS AVAILABLE.
8. TSS FLOW RATES ARE BASED ON A CONCENTRATION OF 2.5 PPM.
9. STREAM 2 REFLECTS INFLUENT DISCHARGE FLOW RATE AFTER TAKING OFF A 100 GPM RECYCLE STREAM.
10. STREAM 10 FLOW RATE IS BASED ON PUMPING ONE BACKWASH VOLUME (=17100 GAL.) IN 5 HOURS. THERE ARE THREE BACKWASHINGS PER DAY. THE RECYCLE IS PUMPED FROM 1T-101 CONTINUOUSLY AT 36 GPM.

C — ISSUE FOR HAZOP REVIEW

Jacobs Engineering Group Inc.
Central Region
Houston, Texas
JOB NO: 35-K784-04

CONTRACT NO. DEL. ORDER 25: F41624-94-D-8115-0025
DWG NO: FS12-1108-002
REV: C
SCALE: NONE

DWG TITLE: MMR PLUME RESPONSE PROJECT
FUEL SPILL - 12 PLUME
PROCESS FLOW DIAGRAM
WATER WELLS / GREENSAND FILTERS

DRAWN: T. ADDINGTON
CHECKED
APPROVED
APPROVED

DWG NO | TITLE — REFERENCE DRAWINGS | NO | REVISION | BY | CHK | APP | DATE

3-10

FIGURE 3-2

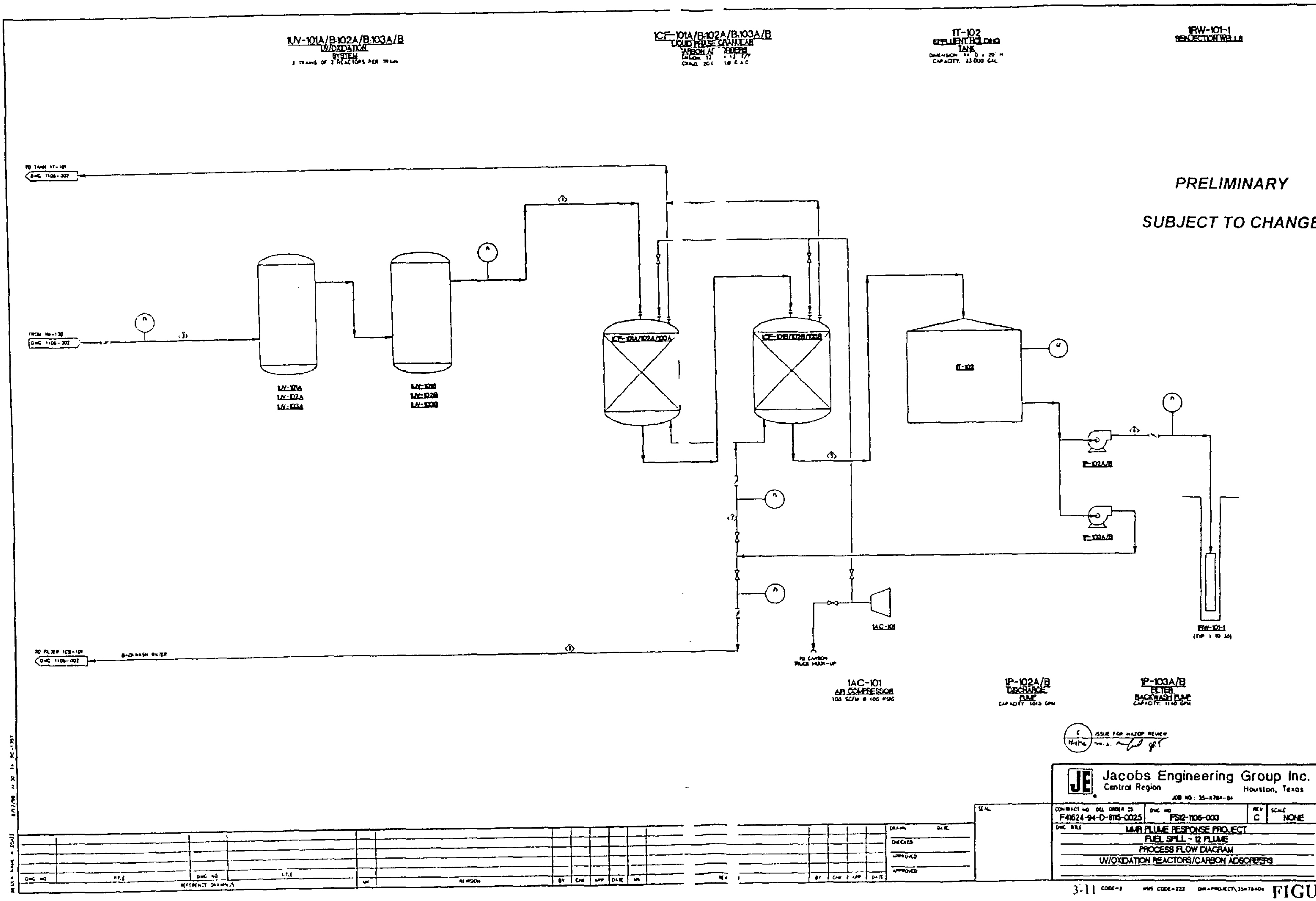
1UV-101A/B-102A/B-103A/B
UV/OXIDATION SYSTEM
1CF-101A/B-102A/B-103A/B
LIQUID PHASE GRANULAR
1T-102
EFFLUENT HOLDING TANK
1RW-101-1
PRELIMINARY
SUBJECT TO CHANGE
1AC-101
AIR COMPRESSOR
1P-102A/B
DISCHARGE PUMP
1P-103A/B
FILTER BACKWASH PUMP
Jacobs Engineering Group Inc.
Central Region
Houston, Texas
F41624-94-D-8115-0025
FS12-1106-003
C
NONE
MMR PLUME RESPONSE PROJECT
FUEL SPILL - 12 PLUME
PROCESS FLOW DIAGRAM
UV/OXIDATION REACTORS/CARBON ADSORBERS

FIGURE 3-3

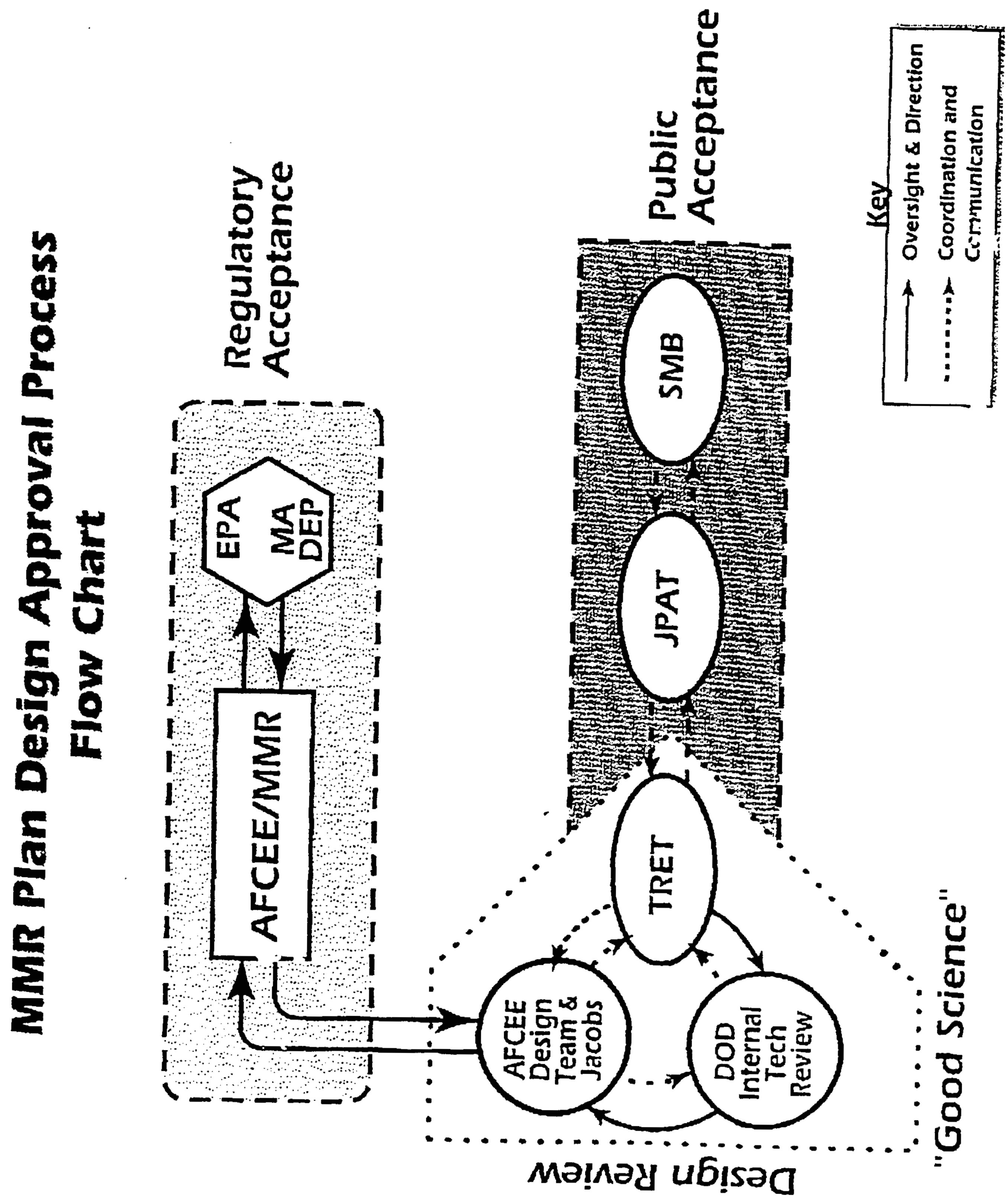

Figure 3-4 MMR Plan Design Approval Process Flow Chart

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4.0 PLUME CONTAINMENT SYSTEM INSTALLATION

All activities described in the following subsections will be performed in accordance with practices and procedures as detailed in the Quality Program Plan (QPP) (Jacobs 1996), which contains the Health and Safety Plan (HSP), Sampling and Analysis Plan (SAP), and the Construction Quality Plan (CQP).

4.1 PRECONSTRUCTION ACTIVITIES

Jacobs will acquire base, local, state and federal environmental and construction permits as required.

Electric power will be supplied by Commonwealth Electric. Sewage will be handled by holding tanks that will be transported for disposal at the MMR treatment facility. Drinking water will be bottled water. Communications to the MMR for services such as fire protection and security during construction will use cellular phones and radios.

Staging areas will be established for permanent materials and field construction equipment. It is anticipated that the area near the ball fields on Camp Good News property will be used as the primary construction equipment staging area.

Prior to the construction mobilization for the FS-12 containment system, a traffic flow pattern will be developed which will respect access easement restrictions, minimize construction traffic through residential areas, and mitigate potential traffic problems on the MMR.

During the construction of the treatment system, it is the responsibility of the site health and safety officer to insure a safe work place. A site-specific Health and Safety addendum to the MMR QPP will be prepared.

The CQP details quality control activities to be carried out during construction and ensures that completed work meets or exceeds design criteria, plans, and

specifications so that all quality objectives are met. Construction operations both on and off site, including work done by subcontractors, fabricators, and suppliers will be performed in accordance with the CQP.

4.2 MOBILIZATION

The construction team will accept all incoming materials and equipment for this project. This acceptance also includes quality control to ensure deliveries meet purchase specifications. Acceptance criteria will be defined in the CQP. Materials that are to be tagged as DOD property will be so, if not already tagged by the vendor.

The construction team will be responsible during construction for the security of the construction site and the materials and equipment purchased. Upon completion, an exterior fence with locked access gate will provide physical security for the treatment facility.

A pre-mobilization kickoff meeting, attended by AFCEE, Jacobs, and the subcontractors, will address the project scope, field procedures, site access conditions, quality control, possible site specific problems, public relations, Investigation Derived Material (IDM) management, and health and safety issues.

Prior to drilling or any other excavation, underground utility clearance will be obtained. Utilities will be marked by MMR personnel for work on the Reservation. For off-site work, utility companies will be notified so they can identify any utilities in the area. Utility clearance will follow procedures outlined in the Standard Operating Procedures (SOP) MMR Tech-001. (This procedure includes MMR "DIGSAFE" procedures.) Geophysical techniques such as ground penetrating radar, magnetics, and electromagnetics may be used to confirm known underground utility and to locate suspected underground utilities that are not shown on utility drawings.

Existing roadways and cleared areas will be used for equipment and system access wherever practical. Care will be taken during all phases of construction activities to minimize disturbances to vegetation and structures. Where cleanup or access construction is required, the minimum footprint will be disturbed.

Erosion run-on and run-off control structures will be installed prior to construction. Sediment barriers including silt fences and staked hay bales may be placed between the sediment source and the area down-gradient of the construction area. There is limited potential for soil erosion at the well sites since the only intrusive activity will be the installation of groundwater wells.

4.3 WELL INSTALLATION AND DATA COLLECTION

The design approach includes additional data collection efforts before and during the initial construction period. These efforts are described in this section.

4.3.1 Preconstruction Data Collection

Installation of new wells at two locations are planned to provide the following information:

- To assess contaminant distribution at approximately 20-40 feet above mean sea level (msl) in the vicinity of the well GMW-20.
- To assess the potential presence of contaminants at approximately 5 to 20 feet above msl between wells GMW-32/GMW-44 and GMW-33.

As illustrated in Figures 1-5 and 3-1, there are no existing monitoring wells in these areas to provide verification of the estimated plume boundary. To assess these concerns, wells will be drilled and installed after comments are received and access is obtained. Groundwater samples will be collected for the contaminants of concern. The general well installation, well development, and well sampling procedures are described in the QPP and will be further described in the draft design package.

4.3.2 Data Collection During Construction

Pilot Boring Program. A series of pilot borings will be drilled prior to drilling and installation of the extraction and injection wells and the system performance monitoring wells. Pilot borings will be installed to better characterize stratigraphy and to delineate the vertical extent of the EDB/benzene plumes. It is anticipated that pilot borings will be installed at approximately 20% of the extraction well and injection well locations, and at approximately 10% of the monitoring wells.

Groundwater screening sampling and analysis will be conducted at pilot boring locations within the EDB/benzene plumes to assess vertical distribution of contamination. Pilot borings at extraction and injection well locations will be continuously sampled (split spoon or split barrel sampler) for geotechnical analysis beginning at a depth of five feet above the designed screen interval down to a depth of five feet below the screen interval. Grain size analysis will be conducted on three to four soil samples collected within this interval at each pilot boring location to help determine the appropriate well screen size and sand pack for the injection and extraction wells. This information will also be used to confirm expected stratigraphic/hydrostratigraphic unit characteristics.

Groundwater Screening Program. Following pilot boring advancement it is anticipated that five screened auger borings (or alternate technology e.g. Hydropunch II ™) will be advanced to further delineate the vertical limits of the EDB plume at the extraction fence locations. The five borings will be equally spaced along the extraction fence to provide spatial distribution. Groundwater samples will be collected at five foot intervals from 50 feet above msl to 50 feet below msl in the borings. Groundwater samples will be analyzed for the contaminants of concern. If groundwater screening results do not agree with the anticipated plume dimensions the need to modify the design (well screen intervals and pumping rates) will be assessed and evaluated in consultation with AFCEE, EPA, the Massachusetts Department of

Environmental Protection (MDEP), and the TRET. Any suggested modifications will be submitted for review and approval.

Step-Drawdown and Step-Injection Test. Following the pilot boring and groundwater screening boring program (and system refinement, if required based on the groundwater screening results), three of the extraction wells and three of the injection wells will be installed. Step-drawdown tests will be conducted at the three extraction wells and step-injection tests will be conducted at the three injection wells. Based on the results of the step tests, assumed aquifer hydraulic characteristics, and modeled drawdown and mounding, the need for model recalibration will be assessed and evaluated in consultation with AFCEE, EPA, MDEP, and the TRET. Any recommended system refinements will be submitted for review and approval.

4.3.3 Monitoring Well Installation

Procedures and construction details for installation of the piezometers and monitoring wells will be described in the Draft Design Package. Monitoring wells will be installed following procedures outlined in SOP MMR Tech-002.

Wastewater will be generated during drilling once the saturated zone is encountered. After drilling is complete the soil/water mixture will be allowed to settle and the water siphoned off. The separated water will be transported to the on-site decontamination and storage yard at the contractor storage area on MMR. Soil cuttings and wastewater generated by drilling activities will be managed in accordance with the Investigative Derived Materials Management Plan (Jacobs, 1996). Wastewater collected during drilling will be stored and later treated after startup of the FS-12 treatment facility.

Where necessary to avoid conflicts with existing land use, wellheads will be constructed in below-ground vaults. Lockable well caps will be placed on all monitoring wells. All constructed wells will be surveyed using a Global Positioning

System (GPS) and the coordinates and elevations will be placed in the database for future Geographic Information System (GIS) purposes.

Monitoring wells/piezometers will be developed using surging, bailing, and/or pumping. In accordance with Jacobs 1996 MMR TECH 004, well development will adhere to the following protocols:

- Developed water has achieved turbidity measurements at or below 5 nephelometric turbidity units (NTUs), at which point NTU requirements are met.
- If an NTU reading of 5 cannot be achieved, the NTU requirement can be satisfied if readings do not exceed 10 NTUs for at least 30 minutes.
- In addition to one of the above NTU requirements being achieved, temperature, pH, and electrical conductivity have to be stabilized to within 1° Celsius (° C), 0.1 pH unit, and 5 percent electrical conductivity, respectively.

4.3.4 Extraction And Injection Well Installation

After pilot boring advancement and groundwater screening sampling described above, extraction and injection well installation will commence. As in the case of the monitoring well installation, wastewater and IDM will be generated and disposed during drilling. Extraction and injection well construction and installation details will be included in the Draft Design Package.

Each extraction and reinjection well will be developed to maximize its efficiency. The effectiveness of the well development effort will be evaluated by conducting a step-drawdown test on approximately 20% of the wells.

4.3.5 Well Disinfection

Following well installation and development, chlorine disinfection will be conducted on all extraction and injection wells to minimize biofouling. Disinfection will be conducted in accordance with applicable sections of the American Water Works Associations Standard C654-87 for disinfection of wells.

4.3.6 Pump Test Data Analysis

Currently it is anticipated that additional pumping tests will not be required as part of the system installation. Pumping test data was collected by ASI in 1993 in the vicinity of the southern edge of the extraction/injection fence (See Section 3.1.2). In addition, OpTech has recently completed an extraction/injection test near the northwest end of the proposed extraction/injection fence, and a limited injection test south of the proposed extraction/ injection fence. When this data is available (anticipated submittal in late September 1996) it will be compared to the previous pump test data to assess variability in aquifer characteristics (specifically hydraulic conductivity).

If the test results vary significantly or are significantly different than the assumed modeling values the need for additional constant rate pumping test(s) will be evaluated. Following analysis of the OpTech pumping test data, the groundwater 3-D model will be revised, if necessary. Reevaluation of the design flow rates and well spacing will be conducted to determine if modifications are necessary. Field conditions (i.e. drawdown) will again be compared with model simulations, if necessary to confirm predictions of the recalibrated model. Following recalibration, a refined pumping scenario will be developed and implemented.

4.3.7 Model Recalibration

Lithologic and geologic data collected during ETR well installation at FS-12 will be reviewed and compared to conditions represented in the resimulation model of FS-12. If significant differences exist between the model representation of the aquifer and the results of field data collection, the model will be revised accordingly and acceptability of the ETR alternative will be confirmed through resimulation.

4.4 TREATMENT FACILITY INSTALLATION

The treatment facility will be constructed using normal construction sequencing and practices. After the location of the site has been surveyed, the area will be grubbed to allow for the necessary excavation work to prepare the site for the foundation work and the installation of utilities and underground piping and electric lines. After the building and equipment foundations have been placed and cured, large equipment will be installed, so that the building shell can be erected. This large equipment includes the influent holding tank, the effluent holding tank, and the sedimentation tank. After the building is erected, the remaining equipment will be installed. If desirable, other equipment may be installed prior to building erection. Piping, instrumentation, and electrical services will be installed and tested. Upon completion of the treatment system and tie-in to the underground piping lines the system will be ready for startup.

4.5 START-UP

Startup of the treatment system will be performed in two steps. Upon completion of the installation, Jacobs and its subcontractors, in conjunction with appropriate AFCEE and base personnel, will check out the electrical, mechanical, and hydraulic elements of the treatment facility. The system will be started using clean water brought to the facility from the ANG Base. The system will then begin using actual groundwater withdrawn through the extraction wells. Startup of the extraction/reinjection wells will be a phased operation. The extraction/reinjection wells will be operated at less than the design flow rates for several weeks to assess groundwater capture and hydrologic environmental impacts prior to full scale operation.

Jacobs will prepare an Operating and Maintenance manual for the FS-12 treatment system. This manual will also include appropriate engineering data for the equipment and materials purchased and installed in this containment system.

4.6 DEMOBILIZATION

Construction demobilization will involve demobilization of contractor equipment/facilities and restoration and landscaping of disturbed areas. Restoration will blend to the surrounding terrain. Since the treatment system will be operating for several years, no formal demobilization/ decommissioning of the wells and treatment facility is included in this text.

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5.0 PERFORMANCE MONITORING NETWORK

The purpose of the groundwater performance monitoring evaluation system (PME) is to determine if the containment system is meeting performance criteria, providing the information necessary to evaluate groundwater flow direction in the vicinity of Snake Pond, and to provide information for the optimization of plume capture over time. The design of the conceptual PME system (as presented below) is based on known aquifer characteristics, the groundwater 3-D model, professional judgment, and principles outlined in Methods of Monitoring Pump and Treat Performance (USEPA, 1994). A detailed PME Plan will be developed as part of the Final Design Package.

The principal objectives of the PME system are:

- Measure the piezometric surface generated by the extraction well and injection well fence to evaluate the effectiveness of vertical and horizontal capture;
- Provide temporal and spatial piezometric and groundwater quality information necessary to guide adjustments to system performance to maintain adequate capture of the contaminant plume in response to changing hydraulic conditions and plume geometry (for example, plume thickness variations with time);
- Provide groundwater quality data within the plume to assess contaminant trends due to system stresses, natural attenuation, and the migration of the more contaminated portions of the plume as they approach the extraction fence;
- Provide groundwater quality data downgradient of the extraction well fence to monitor that contaminant capture at Federal and State MCLs is maintained;
- Provide general water chemistry (physiochemical parameters) data downgradient and side gradient (particularly adjacent to Snake Pond) to assess potential impacts to groundwater chemistry due to system operation; and
- Measure groundwater flow paths induced by the containment system to identify groundwater flow toward or away from Snake Pond.

The monitoring system will be comprised of single well and multi-level monitoring wells/piezometers designed to measure hydraulic and groundwater parameters (contaminants of concern and general groundwater chemistry). Downhole flow meter

(heat-pulse and/or magnetic flow meter) and/or tracer testing may also be used to assess groundwater flow direction and velocities, and to verify capture.

5.1 BASELINE PERFORMANCE MONITORING

Baseline monitoring will be conducted prior to system startup. This data will aid in determining the pre-start conditions for hydraulic gradients, static water levels, distribution and magnitude of the contaminants of concern, and general water chemistry. These monitoring activities will be coordinated with USGS regional monitoring, which is scheduled to begin in the fall of 1996.

Prior to the startup of designed pumping, all wells proposed as sampling locations in the PME Plan will be sampled. Similarly, all hydraulic head (potentiometric surface) gauging locations for any aspect of the PME system will have depth-to-water measurements taken to provide pre-startup baseline. Depth-to-water measurements will be collected on a regular basis to assess regional groundwater flow fluctuations. Wells that will be required for performance monitoring will be identified in the PME Plan. Monitoring/sampling frequency and groundwater sampling parameter identification are discussed later in this section. Detailed baseline performance monitoring will be described in the PME Plan.

5.2 HYDRAULIC PARAMETER MONITORING

Hydraulic monitoring will involve the measurement of the horizontal and vertical components of hydraulic head in the vicinity of the extraction well and injection well fences. Measurements will be made in single-depth piezometers/wells, cluster piezometers/wells, and multi-level samplers (MLSs) using dedicated pressure transducers and depth-to-water level indicators.

Vertical hydraulic gradients will be measured in the MLSs at the extraction and injection fences. These MLSs will be located at the distal ends of each fence

(extraction and injection) segment and at select extraction well and injection well pairs. These MLSs will be installed to target up to five discrete horizons (one will be above the extraction and injection well screen depths, two adjacent to the screen interval [upper and lower portion of the screen] and two monitoring depths below the screen intervals).

Existing MLSs MP59 and MP60 installed by OpTech will be utilized to monitor the southwestern portion of the injection fence adjacent to Snake Pond. In addition, it is anticipated that six additional MLSs will be required to assess vertical gradients adjacent to the fences. The locations of the existing and planned MLS locations will be presented in the PME Plan. The monitored heads will be used to calculate vertical gradients at the extraction and injection fences. This data will be used to estimate the strength and extent of the vertical and horizontal capture field and to refine pumping rates with respect to vertical capture requirements that may change over time in response to plume thickness trends. The data collected from the MLSs, especially those between the injection fence and Snake Pond will also be used to assess potential flow into the pond.

Monitoring wells will be used to measure inward horizontal gradients generated at three depths (immediately above the screen, within the screen interval, and immediately below the screen interval) due to pumping stress. Similarly, other monitoring wells will be used to measure outward horizontal gradients generated at three depths due to injection. These wells will be installed in the following areas: Distal ends of the extraction and injection fences within the anticipated capture zone, immediately upgradient of the anticipated extraction stagnation point, and between the extraction well fence and the injection well fence. Head pressure data from these wells and the MLS wells will be used to determine the projected distance of inward (pumping) and outward (mounding) gradients. Hydraulic heads will be measured at the following depths.

- The mid-point between the top of the extraction fence screens (average of the three nearest extraction or injection wells) and the water table.
- The mid-point of the well fence screen interval (average of the three nearest extraction or injection wells)
- The mid-point between the bottom of the well fence screen interval (average of the three nearest extraction or injection wells) and the bottom of the outwash deposit as based on information collected during the soil boring program described above.

5.3 IN-PLUME CONTAMINANT MONITORING

In-plume monitoring wells will be installed and monitored to provide data on plume thickness changes over time so that appropriate changes in the system operation can be made to refine vertical capture. It is anticipated that two monitoring well clusters (three depths [one above the top of the projected top of the EDB plume and two below the projected bottom of the EDB plume]) will be monitored. It is anticipated that the wells will be placed along a line extending across the plumes (cross-gradient orientation) approximately 250 feet upgradient of the southern portion of the extraction fence and in line with the axis of the plume. Final locations will be identified in the PME Plan. The distance of the wells from the fence will be based on groundwater transport rates and particle tracking simulations, so that the wells are positioned to provide sufficient warning (approximately one to two years) to modify system performance.

5.4 COMPLIANCE MONITORING

Groundwater sampling will be conducted at select wells downgradient of the containment system to act as point-of-compliance wells. Existing wells will be utilized in the compliance monitoring network. The well locations and screen depths will be based on plume definition (as confirmed during the field data collection activity as previously discussed) and the groundwater model capture zone and particle tracking simulations. It is anticipated that well clusters at new locations to supplement the existing network will be required to provide adequate spatial and

vertical coverage downgradient of the containment system. Locations will be identified in the PME Plan. In addition to the monitoring well network, influent water to the treatment plant and at sampling ports within the extraction well pipeline will be used to monitor groundwater quality.

General water chemistry (physiochemical parameters) monitoring will be conducted as part of the PME, but will not be used in the assessment of system performance as related to achieving the required capture criteria. General physiochemical parameter analysis will be conducted at select wells downgradient of the injection system (including those adjacent to Snake Pond) to assess potential changes in groundwater quality due to system operation. Existing MLSs MP59 and MP60 and one of the proposed MLSs will be sampled as part of the PME for the parameters listed in Table 5-1. The sampling locations and a detailed description of the scope of this testing will be presented in the PME Plan.

Table 5-1
Physiochemical Monitoring Parameters for Groundwater

pH
Temperature
Dissolved oxygen
Alkalinity
Conductivity
Redox
Dissolved inorganic carbon
Dissolved organic carbon
Total organic carbon
Ammonia
Nitrate+nitrite
Total phosphorus
Soluble reactive phosphate (SRP)
Cations (including metals)
Anions

6.0 REFERENCES

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OpTech 1996a, Draft Installation Restoration Program, Plume Containment Design Data Gap field Work, Technical Memorandum, Massachusetts Military Reservation, February 1996.

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FS-12 PROJECT EXECUTION PLAN UPDATE

November 1, 1997

The FS-12 Draft Project Execution Plan (PEP) document was written to address actions to complete the engineering/design/construction and operations/monitoring of the extraction, treatment, reinjection (ETR) system for the containment of the FS-12 (Fuel Spill 12) plume. This document was issued for comment 07 September 1996 using the most current information and data available at that time. Comments on the document were received, responded to and resolved with the regulators, TRET and JPAT members and other stakeholders. Attachment 1 lists the comments/responses/resolutions.

Since the publication of the Draft PEP in September 1996, several changes have been made to the plume definition and to the extraction and reinjection wellfield as a result of a pre-construction investigation program conducted following that document's issue. This letter is intended to provide the necessary background to bridge the period between the drafting of the Draft PEP and the current design basis. It will also serve as the vehicle that will close the document review process and result in the PEP becoming final.

The Draft PEP stated that a groundwater and soil sampling during the installation of the extraction and reinjection wells would confirm plume definition and lithology. New information would be incorporated into the basis of design. This program was completed in the late fall and early winter of 1996-1997.

During that period 15 preconstruction monitoring wells, 9 hollow stem auger wells, and 10 soil borings were drilled. 71 soils samples and 320 water samples were taken. The water samples were analyzed for EDB and VOCs. The soil samples were evaluated for lithographic parameters including hydraulic conductivity, aquifer hetergeonity, and anisotropy. Grain size analysis was also performed to finalize screen slot size for the extraction and reinjection wells.

The results of this program resulted in the redefinition of the location and size of the plume and the lithology/stratigraphy make-up of the soil. The plume is now defined as narrower and further to the southeast (Figure 1). The leading edge of the plume is already past the originally planned toe extraction fence and approaching the J. Braden Thompson landfill. The plume also has no western lobe north of Snake Pond.

The revised stratigraphy developed from the soil borings shows less migration of the groundwater into and out of Snake Pond. With this revised stratigraphy and plume re-delineation, extensive modeling efforts proceeded. As various modeling scenarios that represented the development of the well field design based upon the new data and data interpretation were run, results were presented at the technical RPM meetings and various JPAT meetings. A final design was presented to the RPMs, the JPAT, and the TRET in late February 1997. The Draft Technical Memorandum on Groundwater Modeling at FS-12 (28 February 1997 and responses of 12 May 1997) provides the modeling background that has led to the current basis for well configuration and pumping rates. This document was presented to the RPMs and TRET for comment and is being finalized.

The results of the modeling effort and well location/pumping rate adjustments indicated that the overall plume capture was slightly less than 100%. In January 1997, AFCEE agreed to install additional extraction wells to the east and downgradient to capture the escaping particles. It was

also agreed to divide the FS-12 ETR system into two phases to avoid an overall delay to startup of the containment of the system by at least eight months.

Phase I is defined as the original well field configuration and treatment facility as identified in the September 1996 Draft PEP, and as modified through the additional modeling efforts. Phase I has a start-up date of September 24, 1997 (an FFA Milestone). This modified Phase I design consists of 25 extraction wells, 23 reinjection wells on Camp Good News property. The southern extraction well fence was elongated to the east, and pumping rates adjusted to improve capture. The lack of a western lobe to the plume allowed the elimination of several extraction and reinjection wells to the northeast and east of Snake Pond. Figure 1 shows the location of the current well fields for Phase I.

Phase II has been defined as the additional extraction wells that are required to approach the 100% capture of the plume. These wells will be located along State Route 130 and J. Braden Thompson Road, and east of the existing toe fence on Camp Good News property (see Figure 1). These Phase II extraction wells are designed to capture the contaminants that are already past or are expected to pass to the east of the Phase I southern extraction well fence. The Phase I treatment building and process treatment equipment will be used without the need for additional process capacity. The start-up date for Phase II is an FFA enforceable milestone of 15 May 1998.

The process treatment remains the same for both phases. Phase I will extract approximately 850 gpm from the extraction wells. Hydrogen peroxide will be added to the effluent stream to add dissolved oxygen back into the water before being reinjected back into the ground. Sodium hypochorite can be added to the effluent to mitigate iron, biological fouling in the reinjection wells. Phase II will not change the process makeup of the treatment building, and no additional equipment is anticipated to handle the additional throughput.

The draft Performance Monitoring Plan (PME), provides the performance monitoring criteria that will ensure that the facility performs to the criteria set forth in the draft PEP. This document was issued in May 1997. The final PME is scheduled to be submitted upon receipt of comments and response/resolution to the comments. As the performance data becomes available, the PME will be revisited if warranted. The PME will be updated upon completion of the Phase II system.

JACOBS ENGINEERING GROUP INC.

BUILDING 318, 318 EAST INNER ROAD, OTIS ANG BASE, MA 02542
TELEPHONE (508) 564-5746 • FAX (508) 564-6425

January 8, 1997

Mr. Jim F. Snyder
Restoration Program Manager
HQ AFCEE/MMR
322 East Inner Road
Otis ANG Base, MA 02542-5028

RE: MEMORANDUM OF RESOLUTION FOR THE DRAFT FS-12 PLUME CONTAINMENT SYSTEM PROJECT EXECUTION PLAN

Dear Mr. Snyder:

As directed by the Air Force Center for Environmental Excellence, Jacobs Engineering Group Inc. (Jacobs) communicated with the appropriate parties to resolve the responses to comments for the above referenced document. Jacobs is providing herewith a hard copy and an electronic copy of the responses, resolutions and comments for the FS-12 Project Execution Plan.

If you should have any questions or comments, please contact Bob Lenyk at (508) 564-5746, x 231.

Sincerely,

Thomas W. Gorges

Thomas W. Gorges
Program Manager

Enclosures

cc: B. Lenyk
file

Responses to Comments Dated 23 September 1996 on the Draft FS-12 Plume Containment System Project Execution Plan (September 1996)

__Response to USEPA Comments Dated 25 Sept. 1996__

__General Comments:__

1. The level of detail provided in the draft document is less than was anticipated based on previous discussions with AFCEE and Jacobs. As discussed during the September 19, 1996 Remedial Project Managers' (RPM) meeting, it was EPA's understanding that the conceptual basis for the design as well as the proposed program for monitoring system startup and long term operations would be included in the draft execution plan. The draft FS-12 plume containment execution plan submitted on September 8, 1996, however, simply presents an overview of the primary elements of the FS-12 containment and treatment system and identifies the scope of data and information to be provided as part of the draft design package. Please explain.

   __Response:__ As noted, the Draft Execution Plan presents an overview of the primary elements of the ETR system. The contents of the Draft Design Package had been presented, discussed, and agreed upon at the RPM meetings. The conceptual basis for the design will be published in the Draft Design Package scheduled to be submitted on 21 October 1996. Details of the performance monitoring system will be presented in the Final Design Package.

   __Resolution:__ As per October 15, 1996 telephone call with Carol Keating from the EPA, the EPA found the response satisfactory, with no need for additional modifications.

2. The groundwater performance monitoring evaluation (PME) system is an important part of the execution plan, but is not included as part of the document. In lieu of the PME plan, EPA recommends that tables be included in Section 5 that list parameters to be measured, methods used, detection limits (where appropriate), and the approximate number of samples (including QC samples) for each of the Subsections 5.1 through 5.4. Also, will an on-site laboratory, an off-site laboratory, or both be utilized for contaminant monitoring?

   __Response:__ We anticipate that the Draft PME will be available for review in early December, at least one month prior to submission of the Final Design Package, of which it will be a part. The Draft PME is utilizing and coordinating historical information as well as data from three ongoing tasks: the inorganics investigation, the ecological monitoring program, and the additional data gap field effort. In particular, because the data gap drilling will be ongoing for at least one more month, we will be completing the Draft PME after those results are compiled in mid to late November.

   With regard to the laboratory analyses, the Draft PME will utilize data being collected as part of all three programs listed above. Parameters, methods, detection limits, numbers of samples, and sampling locations will be detailed in the Draft PME. With regard to the type of laboratory, we anticipate using an on-site laboratory for data collection during system startup and early monitoring of the system. Once we are satisfied that initial performance criteria are being met, an off-site laboratory will probably be used.

Resolution: As per October 15, 1996 telephone call with Carol Keating from the EPA, the EPA found the response satisfactory, with no need for additional modifications.

3. Major elements of the draft design submittal are summarized in Section 2.4. This section should be expanded to specify and describe all proposed programs to evaluate system startup, plume capture, hydraulic containment, ecological impact, residuals management and system performance (e.g. treatment system performance, extraction well performance, and injection well performance).

   Response: The Project Execution Plan (PEP) is intended to present an overview of that to be presented in other documents such as the PME and Draft Design Package. As noted above in the response to comment #2, the PME will synthesize data from several historical and ongoing investigations. This data will be used to develop the baseline required to measure the performance of the ETR system.

   Resolution: As per October 15, 1996 telephone call with Carol Keating from the EPA, the EPA found the response satisfactory, with no need for additional modifications.

Specific Comments:

- **Comment #1, Page 4-4, 3rd paragraph:** The groundwater screening program must be performed early enough in the program in the event that there is a need to modify the design to ensure there are no delays to the schedule.

  Response: Agreed. To ensure that groundwater screening information is available prior to final construction, a groundwater screening and lithology investigation will be conducted in October 1996. Suitable locations for the groundwater screening/lithology investigation were discussed in the FS-12 design basis meeting on September 30, 1996. The groundwater screening/lithology locations will be presented in the Draft Design Package to be submitted on 21 October, 1996.

  Resolution: As per October 15, 1996 telephone call with Carol Keating from the EPA, the EPA found the response satisfactory, with no need for additional modifications.

- **Comment #2, Page 5-6, Table 5-1:** The table should be amended to include method numbers, detection limits, and the approximate number of samples (please see comment 2 above).

  Response: See response to general comment No. 2.

  Resolution: As per October 15, 1996 telephone call with Carol Keating from the EPA, the EPA found the response satisfactory, with no need for additional modifications.

Responses to A.K. Lo (AFCEE) Comments Dated 16 Sept 1996

- **Comment #1, Page 3-4, para. 3.1.2:** The groundwater flows south to southeast as indicated in the text. The proposed reinjection wells that are along the west and south edges of the plume will function as a hydraulic barrier to deny the plume moving south but to southeastern. With this scenario, the proposed western extraction well locations as shown on Fig. 2-1 and Fig. 2-2, appear to be ineffective in capturing the plume.

  Response: The primary purpose of the proposed reinjection wells was to minimize drawdown at Snake Pond in response to ecological concerns. The reinjection wells are not required to maintain plume capture. The western extraction fence is required to capture the EDB plume as currently defined. The significance of the western portion of the EDB plume will be assessed during the groundwater screening program discussed above. The necessity for the western extraction fence will be verified based on the screening results.

  The most recent modeling simulations predict 100 % mass capture of the western portion of the plume based on the well locations as shown. Jacobs is currently in the process of performing additional model simulations, with minor modifications of the well locations (including reducing the number of wells north and east of Snake Pond), to optimize the well placement and to provide minimal impact on the ecological systems.

  Resolution: As per October 15, 1996 telephone call with A.K Lo from AFCEE, Brooks Air Force Base, Texas, AFCEE found the response satisfactory, with no need for additional modifications.

- **Comment #2, Page 3-6, Process Flow Diagram (PFD):** Please identify and express at what level of confidence on the assumptions that Jacobs used to develop the FS-12 PFDs.

  Response: To provide more confidence in the concentrations used as a basis for the design, Jacobs has contracted with OpTech to update their existing data base which includes the concentrations of contaminants in monitoring wells in the FS-12 and SD-5 plumes. The information in this data base will then be used to calculate "weighted average" concentrations of expected contaminants based on the specified locations of the extraction wells. The information will be used to update the PFDs in the Final Design Package.

  Jacobs is also currently analyzing the results of the recent FS-12 pumping test , with emphasis on conductivity. Groundwater modeling scenarios are being run with higher hydraulic conductivity values and pumping rates to ensure the design provides adequate plume capture if the conductivity for the site is raised from the initial modeling parameters. Following the modeling runs and the verification of the pumping tests, the need for changing the current design will be evaluated.

  Resolution: As per October 15, 1996 telephone call with A.K Lo from AFCEE, Brooks Air Force Base, Texas, AFCEE found the response satisfactory, with no need for additional modifications.

- **<u>Comment #3, Page 4-3, para. 4.3.1:</u>** Other than the lack of monitoring wells in the GMW-32/GMW-44 areas, it appears that monitoring wells are also absent in the GMW-33 to GMW-36 and WT-6 areas to define the edge of the plumes especially if the plume is moving to that direction.

  <u>Response:</u> To address plume data gaps, a groundwater screening investigation will be conducted in October 1996, prior to completing the final design. To better define plume boundaries, additional groundwater samples will be collected throughout the FS-12 area.

  <u>Resolution:</u> As per October 15, 1996 telephone call with A.K Lo from AFCEE, Brooks Air Force Base, Texas, AFCEE found the response satisfactory, with no need for additional modifications.

- **<u>Comment #4, Page 2-6, para. 2.4, Volume III of design submittal:</u>** This volume contains major equipment specifications, it is recommended that one copy is distributed to Otis for maintenance purpose and one copy to AFCEE at San Antonio for record and reference.

  <u>Response:</u> Distribution of the Final Design documents will be coordinated with AFCEE.

  <u>Resolution:</u> As per October 15, 1996 telephone call with A.K Lo from AFCEE, Brooks Air Force Base, Texas, AFCEE found the response satisfactory, with no need for additional modifications.

Responses to R. Peebles (AFCEE) Comments Dated 20 Sept 1996

General Comment #1: I have reviewed the above referenced document and my comments concerning hydrology are as follows:

This project is based on data, which we have reviewed previously. The data was found in many cases to be questionable.

The proposed Performance Monitoring Network as described in Section 5.0 is extremely detailed and costly. Its principal purpose is to meet performance criteria. Define "performance criteria" and provide these criteria in this document.

The last objectives in the PME system objective list (Section 5.0) is to "measure groundwater flow paths". Explain how the flow paths will be measured.

Section 5.1 is titled Baseline Performance Monitoring. The first sentence of this section states that baseline monitoring will be conducted prior to system startup. How do you monitor performances prior to system startup?

The last sentence of Section 5.1 states that "detailed" baseline performance monitoring will be described in the PME plan. Where is baseline performance monitoring discussed in Section 5.1?

The PME plan should state very clearly and in detail all performance criteria and specify how all network components will meet these criteria. All proposals to gather data in order to improve the "understanding" of the hydrology/hydrogeology of the FS-12 site should be rejected unless they have a demonstrated direct bearing on performance criteria. The Air Force should not pay for data that are of a research nature of satisfy some scientific objective.

We look forward to reviewing the PME proposal in detail and hope that we will be given sufficient time to carry out a thorough review.

Response: To address data uncertainties, a groundwater screening/lithology investigation will be conducted prior to completion of the design. Detailed information regarding the groundwater screening investigation will be provided in the Final Design Package.

In addition, several questions are asked regarding the details of the Performance Monitoring Evaluation System (PME). Section 5.0 of the PEP was meant to provide an overview of the purpose of the PME without developing the necessary details of system development and operation. The Draft PME Plan, which will be part of the Final Design Package (see responses to USEPA comments 2 and 3), will define "performance criteria" and specify how the components of the PME will have a direct bearing on the measurement of performance criteria. For efficient completion of the Final PEP, we propose that the detailed responses to these comments be deferred to the Draft PME Plan.

The initial monitoring is not intended to measure system effectiveness, but rather to establish baseline conditions (i.e., groundwater contaminant concentrations, groundwater elevation,

etc.) prior to design startup. Baseline conditions have to be established before startup of the ETR system to measure its performance once it is implemented.

The data collection activities specified in the PEP are necessary to ensure the ETR design is sufficient to achieve the remediation objectives. It is not Jacobs' intention to include any unnecessary data collection beyond what is required to demonstrate performance criteria are being met. However, since the MMR project requires evaluating the impacts to ecological receptors, area ponds, and wetlands in addition to more traditional requirements such as contaminant concentrations and groundwater elevations, the level of required monitoring is higher than most sites.

Resolution: As per October 18, 1996 telephone call with Roger Peebles, AFCEE found the response satisfactory, with no need for additional modifications.

Responses to L. Lumeh (ETA) Comments Dated 20 Sept 1996

General Comments: The proposed remedial action is fundamentally the same as suggested in the 60% plume containment design by OpTech in March this year. The logical question to ask is why this plan has been implemented without any more understanding or addressing of the problems which rendered it unacceptable back then. This document even highlights some of the problems, and suggests that answers to these problems be sought as the plan implementation progresses. What if the results of further investigation prove to be unacceptable when half of the system is already installed?

In addition to the problems already identified, the reinjection scenario described in the document needs to be seriously evaluated. The plan is that the water will be reinjected at the same rate as it is pumped, by the same number of wells. Practical experience is that the ratio of reinjection to pumping wells is as least 2, all other things being equal. Furthermore, reinjection systems very often need backups for cleaning and maintenance, so that the current plan for 30 reinjection wells will cause serious operational problems.

The investigation of the ecological effects of a plan such as is being considered should not be concurrently evaluated with implementation of the plan.

Finally, the combination of UV treatment and carbon adsorption is questionable, unless the carbon is being used as insurance (to polish) against discharging contaminants above the regulated limits. In that case, the quantities are small compared to those suggested in the 60% design.

Response: It should be noted that the proposed design is significantly different than the former 60% design. The pump rates specified at FS-12 in this Execution Plan are approximately 40% lower than those in the former 60% design. Subsequently, drawdowns have been reduced, thereby minimizing impacts to sensitive ecosystems without compromising human health protection objectives. In addition, unlike the 60% design, groundwater extraction wells have been placed along the axis of the plume as well as at the toe in an effort to more rapidly remove the concentrated portions of the plume.

We agree that "Practical experience is that the ratio of reinjection to pumping wells is at least 2, *all other things being equal.*" However, most ETR systems would operate with much higher well spacing and pumping rates than those specified in this design, resulting in less extraction wells, but approximately the same number of reinjection wells. As a point of reference, aquifer pumping tests performed at the site indicate that the aquifer is capable of producing 800-1200 gpm per well. In comparison, extraction and reinjection rates specified in the FS-12 design are approximately 30 gpm per well. The low rates of pumping and reinjection proposed for this system will not impose a significant stress on the aquifer or wells (i.e. calculations of entrance velocities for the reinjection wells do not project significant operational problems).

Potential ecological impacts of the remedial action are being considered and evaluated concurrently with this design plan.

Because the design basis for treatment is to reduce the concentration of toxic organic contaminants to below the detection limit, activated carbon is the selected final treatment option - carbon is capable of removing most organic contaminants to non-detectable concentrations. However, at FS-12, because the organic concentrations are relatively high, it is not economical to remove all the organic compounds using activated carbon alone. The purpose of the UV/peroxide system is to pretreat the water to remove approximately 90% of the organics upstream of the carbon. The UV/peroxide is not required to meet the effluent requirements, but is economical to reduce the carbon consumption.

Resolution: As per October 18, 1996 conversation with Larry Lumech from ETA, ETA is satisfied with the response, however the need to monitor the entrance velocities was reiterated.

Responses to D. Hill (Bregman & Company) Comments Dated 23 Sept 1996

- **Comment #1, Section 2.3 (Planned Actions), pg 2-4, paragraph 2,4:** The Process Action Teams (PATs) should be included in any listing of review parties.

  Response: The JPAT FS-12 Focus Group has been added to paragraphs 2 and 4 as part of the review process.

  Resolution: As per October 18, 1996 telephone call with Dave Hill from Bregman and Company, Bregman and Company found the response satisfactory, with no need for additional modifications.

- **Comment #2, Section 2.4 (Project Deliverables), pg 2-6**: Please be sure to provide a complete set of all design documents to NGB/Army (Aberdeen PG and Camp Edwards) and the Army Environmental Center.

  Response: Distribution of the Final Design documents will be coordinated with AFCEE to include all agreed upon appropriate Army parties.

  Resolution: As per October 18, 1996 telephone call with Dave Hill from Bregman and Company, Bregman and Company found the response satisfactory, with no need for additional modifications.

- **Comment #3, Section 2.5 (Schedule), pg 2-6:** The enforceable milestone dates included here do not match the corresponding activity dates contained in the latest (8/15/96) copy of the Plume Response Schedule (sorted by task and summary). An appropriately updated master MMR Plume Response Plan detail schedule, with final negotiated enforceable milestone dates incorporated, needs to be distributed.

  Response: The "enforceable milestone" dates listed as part of the Draft PEP are proposed. These proposed milestones were agreed upon at the RPM meetings but have yet to be finalized. After the dates are finalized, they will be incorporated into an updated master schedule for distribution.

  Resolution: As per October 18, 1996 telephone call with Dave Hill from Bregman and Company, Bregman and Company found the response satisfactory, with no need for additional modifications.

- **Comment #4, Table 2.1**: Which wells are included in the groupings designated by the subheadings on the table (i.e. Central Reinjection Wells; South Axial Extraction Wells)?

- **Response**: The Final Execution Plan will identify wells by number on the plan view map and table.

  Resolution: As per October 18, 1996 telephone call with Dave Hill from Bregman and Company, Bregman and Company found the response satisfactory, with no need for additional modifications.

- **Comment #5, Section 3.2 (Design Methodology), pg 3-7, paragraph 1**: "Absorption" should be changed to "adsorption."

- **Response:** "Absorption" will be edited to "adsorption."

  Resolution: As per October 18, 1996 telephone call with Dave Hill from Bregman and Company, Bregman and Company found the response satisfactory, with no need for additional modifications.

- **Comment #6, Section 3.2 (Procurement Interface), pg 3-8, last paragraph**: "Records" should be changed to Regulations. Also, 2nd sentence needs a grammar check.

- **Response**: "Records" will be edited to "Regulations." A grammar check will be done.

  Resolution: As per October 18, 1996 telephone call with Dave Hill from Bregman and Company, Bregman and Company found the response satisfactory, with no need for additional modifications.

Responses to L. Pinaud (MDEP) Comments Dated 23 Sept 1996

- **Comment #1**: The Department supports the Plan and appreciates its flexibility and AFCEE's commitment to undertake additional actions to insure the extraction-treatment-injection system (the "ETR") will work effectively.

  Response: No response necessary.

  Resolution: As per discussions between Edward Pesce from IRP and Leonard Pinaud from MDEP, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #2**: As AFCEE appraises the Department of the technical justification for the extraction and injection plan, the preconstruction data collection plan, the pilot borings plan, the groundwater gauging and monitoring plans, the Department will be prepared to comment on the technical merits of the project.

  Response: No response necessary.

  Resolution: As per discussions between Edward Pesce from IRP and Leonard Pinaud from MDEP, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #3**: There are extensive data gaps along the margins of the body of the FS-12 Plume. The data gaps addressed in the 60% design focused exclusively on defining the toe of the FS-12 Plume. However, the Plan calls for an extensive axial plume containment element that requires accurate definition of the body of the Plume. The two exploratory borings proposed by the Plan are insufficient. These data gaps are readily identified and easily filled. The Department requests that AFCEE undertake exploratory drilling to remedy data gaps at FS-12 now.

  Response: In addition to the proposed preconstruction data collection, additional data will be collected during construction (Section 4.3.2) and well installation (Sections 4.3.3 and 4.3.4) of the ETR system described in the Draft Execution Plan. To address data uncertainties, a groundwater screening/lithology investigation will be conducted prior to completion of the design. Information regarding the groundwater screening investigation will be provided in the Final Design Package.

  Resolution: As per discussions between Edward Pesce from IRP and Leonard Pinaud from MDEP, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #4**: The Plan states "The goal of the FS-12 plume containment project is to identify a network of extraction and reinjection wells that will capture as near 100% of the plume as possible without unacceptable ecological, hydrological or other impacts." (Section 1.0 INTRODUCTION, paragraph 2, page1-1). The Department suggests that this statement be rewritten to read "The goal of the FS-12 plume containment project is to design, install and operate an ETR system that will capture 100% of the plume without unacceptable ecological, hydrological or other impacts."

Response: The suggested text modification is as follows: "The goal of the FS-12 plume containment project is to design, install and operate an ETR system optimizing capture of the plume while minimizing adverse impacts to the ecological, hydrological or other impacts."

Resolution: Pursuant to discussions between Edward Pesce from IRP and Leonard Pinaud from MDEP, the resolution is that the text will be modified to read:

> **Response:** The suggested text change is acceptable with the following amendment. "The goal of the FS-12 plume containment project is to design, install and operate an ETR system striving for 100% capture of the plume, if feasible, without unacceptable ecological, hydrological, human health of other impacts." Without the caveat it gives the impression that 100% capture will definitely occur. Nothing is 100% absolute, and therefore we are striving for that goal.

- **Comment #5**: The Plan states "The principle objectives of the PME (Performance Monitoring Network) system are....Provide groundwater quality data downgradient of the extraction fence to monitor that containment capture at Federal and State MCLs is maintained;..."(Section 5.0, PERFORMANCE MONITORING NETWORK, paragraph 2, bullet 4, page 5-1). This statement suggests that containment to MCLs is the accepted containment and cleanup standard. It is not. Groundwaters of the Commonwealth must be restored to background levels, if feasible. Please rewrite this statement to read "...The principal objectives of the PME system are:...Provide groundwater quality data downgradient of the extraction fence to verify that contaminant capture to background levels is maintained;..."

  Response: The text will be modified to state "...The principal objectives of the PME system are:... Provide treated groundwater below MCLs to be reinjected downgradient of the extraction fences. Using the Best Available Control Technology, the treated groundwater coming from the ETR Treatment Facility will approach levels of non-detect for the contaminants removed."

  Resolution: Pursuant to discussions between Edward Pesce from IRP and Leonard Pinaud from MDEP, the resolution is that the text will be modified to read:

  > **Response**: Agreed. The text will be modified to state "...The principal objectives of the PME system are:... Provide groundwater quality data downgradient of the extraction fence to verify that the contaminant capture goal is maintained, if feasible."

- **Comment #6:** Total Suspended Solids influents are listed as 2.5 ppm in Figure 3-2 on page 3-10 of the Plan. This is a 10-fold decrease of the concentration proposed in Figure P-2 of the 60% Design (22.05ppm). Please explain this difference.

  Response: The previous TSS data was not considered as representative of the TSS that would be expected in a fully developed extraction well. The previous data was collected from monitoring wells with no sand pack, and the underdeveloped formation was allowed to collapse around the screen. The extraction wells will have fully developed sand packs and will be sufficiently developed to remove fines from the area of the wells, and thus are expected to have considerably lower TSS concentrations. This value is considered to be a safe assumption based on information from other wells at the site such as the Coonamessett

well and the CS-4 plume containment wells. The TSS at those wells is less than 1.0 ppm, making the design assumption conservative. However, to be sure, TSS will be analyzed during pumping tests proposed for this fall. These pumping tests will provide better information because the data will be collected after the initial surge of solids has been washed out of the wells. TSS sampling will be taken during the preconstruction data gap sampling program.

Resolution: As per conversation between Edward Pesce from IRP and Leonard Pinaud from MDEP, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #7:** Please specify the pH in Stream No. 2 of figure 3-2, page 3-10 of the Plan.

  Response: The pH in Stream No. 2, Figure 3-2, will be provided.

  Resolution: As per conversation between Edward Pesce from IRP and Leonard Pinaud from MDEP, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #8:** Please provide a key to the various symbols and patterns used in Figure 3-2, page 3-10 of the Plan.

  Response: A key will be provided.

  Resolution: As per conversation between Edward Pesce from IRP and Leonard Pinaud from MDEP, the DEP found the response satisfactory, with no need for additional modifications.

Responses to J. Dickerman and C. Runck (HAZWRAP) comments dated 23 Sept 1996

- **Comment #1, Page 1-6, Figure 1-2:** Page 1-6, Figure 1-2: Noting the wetland area designated to the North of Snake Pond, I would suggest that the Ecological Monitoring of the surrounding ecological resources include some baseline characterization of that wetland area. Perhaps it was already delineated recently. At a minimum, I would suggest the monitoring of the GMW-22 and GMW-4 to assure minimization of impact to the ecological resource. A recent USGS publication.

  Response: Comment 1 is noted. The ecosystems that are potentially within the influence of the treatment system will be characterized. Baseline characterization activities and the monitoring network (i.e., monitoring wells, piezometers) for assessment of potential impact to the ecosystems will be presented in the FS-12 Ecological Monitoring Work Plan. Physiochemical parameters presented in Table 5-1 will be monitored as described in the FS-12 Ecological Work Plan, scheduled to be submitted on 15 November.

  Resolution: As per October 17, 1996 telephone call with Joyce Dickerman from HAZWRAP, HAZWRAP found the response satisfactory, with no need for additional modifications.

- **Comment #2, Page 2-1, Sect. 2.0, last paragraph, last sentence:** Suggest changing language from the contaminant risk language to the impacts language. Change 'receptors' to 'resources'.

  Response: "Receptors" will be changed to "resources."

  Resolution: As per October 17, 1996 telephone call with Joyce Dickerman from HAZWRAP, HAZWRAP found the response satisfactory, with no need for additional modifications.

- **Comment #3, Page 2-2, Sect. 2.1, third paragraph, last sentence:** Suggest changing language to more accurately reflect status to - Efforts to develop specific criteria for identifying acceptable or unacceptable ecologic impacts has been initiated for surface water resources in the vicinity of the proposed ETR at FS-12.

  Response: Complete ecological monitoring will be presented in the FS-12 Ecological Work Plan scheduled for submittal on 15 November, 1996.

  Resolution: As per October 17, 1996 telephone call with Joyce Dickerman from HAZWRAP, HAZWRAP found the response satisfactory, with no need for additional modifications.

- **Comment #4, Page 2-3, Sect. 2.2, first paragraph, second sentence:** Suggest changing 'on the ecology' (which is a field of study) to 'to ecological resources' AND changing 'will' to 'may'.

  Response: The text will be edited as requested.

Resolution: As per October 17, 1996 telephone call with Joyce Dickerman from HAZWRAP. HAZWRAP found the response satisfactory, with no need for additional modifications.

- **Comment #5, Page 2-4, Sect. 2.3, second paragraph, first sentence:** Suggest changing 'receptors' to 'resources' as per comment 1. above.

  Response: "Receptors" will be changed to "resources."

  Resolution: As per October 17, 1996 telephone call with Joyce Dickerman from HAZWRAP, HAZWRAP found the response satisfactory, with no need for additional modifications.

- **Comment #6, Page 5-6, Sect. 5.4, Table 5-1:** The physiochemical monitoring parameters for groundwater are listed very generically. Certainly when the details of the Compliance Monitoring are discussed, it will be important to disclose the specific cations and anions and the analytical methodologies. If an Inductively Coupled Plasma-emission Spectroscopy (ICP) "sweep" is done then the following cations and metals, which have limnological significance (e.g., primarily as essential nutrients or micronutrients for plants and animals)would be (as they should be) measured:

  - boron (essential micronutrient for algae/plants)
  - calcium (essential nutrient for algae/plants, animals; nerve, muscle function)
  - cobalt (essential micronutrient for algae/plants)
  - copper (essential micronutrient for algae/plants)
  - iron (essential micronutrient for plants and animals)
  - magnesium (essential nutrient for algae/plants)
  - manganese (essential micronutrient for algae/plants)
  - molybdenum (essential micronutrient algae/plants)
  - potassium (osmotic balance; nerve function)
  - selenium (essential micronutrient for algae/plants)
  - silica (essential nutrient for diatom algae)
  - sodium (osmotic balance; nerve function)
  - vanadium (essential micronutrient for algae/plants)
  - zinc (essential micronutrient for algae/plants)

  The following anions are also of limnological significance and should be measured:

  - chloride (osmotic balance; nerve function)
  - sulfate (essential nutrient for algae/plants, animals)
  - carbonates (buffering capacity; basic to lake metabolism)

  If ICP sweeps, that includes calcium and magnesium, are performed, then hardness would not need to be measured.

  Response: Physiochemical parameters will be monitored under the ecological sampling program but will not be used to assess the FS-12 ETR system performance. The data will instead be used to assess potential ecological impacts of the system. All of the parameters

listed in the comment and the specific wells in which they will be sampled for will be included in the FS-12 Ecological Monitoring Work Plan.

Resolution: As per October 17, 1996 telephone call with Joyce Dickerman from HAZWRAP, HAZWRAP found the response satisfactory, with no need for additional modifications.

JE®

JACOBS ENGINEERING GROUP INC.

BUILDING 318, 318 EAST INNER ROAD, OTIS ANG BASE, MA 02542
TELEPHONE (508) 564-5746 • FAX (508) 564-6425

December 8, 1997

Mr. Jim F. Snyder
Remediation Program Manager
HQ AFCEE/MMR
322 East Inner Road, Box 41
Otis ANG Base, MA 02542-5028

RE: Final Project Execution Plan for FS-12 Containment System

Dear Mr. Snyder:

As directed by the Air Force Center for Environmental Excellence, Jacobs Engineering Group Inc. is hereby providing twenty seven bound and one unbound copy of the addendum letter and attachments for the *Draft Project Execution Plan for FS-12 Containment System*, dated September 1996. The designated number of copies are also being sent to the United States Environmental Protection Agency, the Commonwealth of Massachusetts Department of Environmental Protection, the United States Army National Guard, and other recipients of the original document.

This addendum includes a letter updating what has occurred on the project since the draft report was written, a current well field layout, and the comments/responses/ resolutions to the draft document. Please incorporate this addendum document into your Draft Project Execution Plan. If you were not on the initial distribution list, individual requests for a full set of the original draft documents will be honored until January 15, 1998.

This addendum letter and attachments now complete the necessary protocols with the regulator and AFCEE concurrence to make the Project Execution Plan a final document.

Please feel free to contact Larry Eitel or myself at (508) 564-5746 extension 264, if you have any questions or comments.

Sincerely,

Thomas W Gorges

Thomas W. Gorges
Program Manager

Enclosure: Document (28)

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JACOBS ENGINEERING GROUP INC.

cc:

EPA:
Paul Marchessault (3)

DEP:
Lynne Doty (1)
Andrea Papadopoulos (3)
Leonard Pinaud (1)

ARNG:
David Hill (c/o IRP) (1)
JoAnn Watson (1)
Larry Lumeh (1)
Mary Ellen Maly (1)

GANNETT FLEMING:
Rayomand Bhumgara (2)

CONSERVATION OFFICER(S):
Mark Galkowski (1)

FOOT HILL ENGINEERING:
Jim Quinn (1)

JACOBS ENGINEERING GROUP INC.:
Tom Gorges (1)
Tim Forden (1)
George Petersen (1)
Larry Eitel (1)
Bob Lenyk (1)
Karen Wilson (w/o attachment)
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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

8 January, 1998

MEMORANDUM FOR SAF/LLP
ATTENTION: MS CHARLOTTE MOYER

FROM: HQ AFCEE/MMR
322 E. Inner Road, Box 41
Otis ANG Base, MA 02542-5028

SUBJECT: Final Report

1. Attached please find five (5) copies each of the document entitled "Final FS-12 Plume Containment System Project Execution Plan" dated December 1997.

2. If you have any questions, please call me at 508-968-4670, extension 4912.

JIM F. SNYDER
Remediation Program Manager

Attachment:
Document (5 copies)

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

8 January, 19986

MEMORANDUM FOR NGB-PAI-E
ATTENTION: MR. JOHN REINDERS

FROM: HQ AFCEE/MMR
322 E. Inner Road, Box 41
Otis ANG Base, MA 02542-5028

SUBJECT: Final Report

1. Attached please find a copy of the document entitled "Final FS-12 Plume Containment System Project Execution Plan" dated December 1997.

2. If you have any questions, please call me at 508-968-4670, ext. 4912.

JIM F. SNYDER
Remediation Program Manager

Attachment:
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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

8 January, 1998

MEMORANDUM FOR HQ AFCEE/JA
ATTENTION: MAJOR WALTER KING

FROM: HQ AFCEE/MMR
322 E. Inner Road, Box 41
Otis ANG Base, MA 02542-5028

SUBJECT: Final Report

1. Attached please find a copy of the document entitled "Final FS-12 Plume Containment System Project Execution Plan" dated December 1997.

2. If you have any questions, please call me at 508-968-4670, ext. 4912.

JIM F. SNYDER
Remediation Program Manager

Attachment:
Document

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

8 January, 1998

MEMORANDUM FOR NGB/JA
ATTENTION: MS. ROSEANN SENDEK

FROM: HQ AFCEE/MMR
322 E. Inner Road, Box 41
Otis ANG Base, MA 02542-5028

SUBJECT: Final Report

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2. If you have any questions, please call me at 508-968-4670, ext. 4912.

JIM F. SNYDER
Remediation Program Manager

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